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Research Paper

Percentage Moisture Content Assessment of some Selected Plots of *Eucalyptus camadulensis* and *Pinus caribeae* Plantation Soil Types in Kaduna State, Nigeria

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ABSTRACT:- Two study sites comprising *Eucalyptus camadulences* and *Pinus caribeae* were selected with a control site adjacent which is the regrowth forest in Igabi Local Government Area. Also, two 50 x 50 sample plots were designed while different spots were randomly sampled using ballot systems. Soil sample taken at two depths are from 0 – 20cm and 20 – 40cm. The initial and constant weight of 1.5kg was subjected to all the soil samples collected. *Eucalytus camadulensis* plantation had the highest percentage moisture content which was found at the lower soil depth (20 – 40cm) with a value of 73 percent on spot 3. The lowest soil moisture content was recorded in top soil of plot A of Regrowth vegetation with a value of 17 percent. It was followed closely by plot B spot 4 of *Eucalyptus camadulensis* plantation topsoil with a recorded value of 22 percent. The outcome of the result from the test of mean shows that P(T<=t) at 0.05 confidence level is 0.39. It was also concluded that since there is no significance difference between the soil moisture content from the regrowth forest and those from Pine and Eucalypt plantations, little perturbation might have occurred but revitalization of the forest is prognostic of recuperation. Therefore heavy formation of similar project of plantation goes a long way to improve the moisture relation between the soils and vegetation.

Keywords:- Plantation, Moisture, Soil, Weight, Porousity, Capillarity

I. INTRODUCTION

Soil Moisture and Vegetation Interaction

Plants depend on soil moisture activity in their response to environmental climate variability within which they are found especially in the arid and semi-arid zones as it was stated that the interaction between vegetation and soil moisture dynamics contributes to structure and function in arid and semiarid ecosystems (Noy-Meir, 1973; Walker *et al*., 1981; Scholes and Archer, 1997; Rietkerk and van de Koppel, 1997). D'Odorico and Porporato (2006) also declared this depends on the availability of soil water resources, which results from plant interactions within the soil water balance. This was also supported by Greene, 1992; Greene *et al*., 1994; Breman and Kessler, 1995; Bhark and Small, 2003. Moisture is therefore a key component driver of plant distribution and climate which is responsible for the sparse distributions of vegetation in the savanna vegetation subtypes (Schlesinger *et al*., 1990; Belsky1994). The soil moisture make-up determines the plants that survive the nature of such soil environment. The roots of plants in the swamps are characterized by buttresses with pnematophores because of high salinity and heterogeneous patterns of root zone soil moisture.

II. STUDY AREA

This work looked at the soil moisture capacity in selected forest types in Nigeria Guinea Savanna. Kaduna, a state in central northern Nigeria located within the geographic location of 10^0 20^IN and 7^0 45E with a total area of 46,000 km^2. It was founded by the British. It occupies the central position of the northern part of Nigeria with a population of 760,084 and situated along Kaduna River. It shares common boundries with Zamfara, Kano, Niger, Bauchi, Katsina and Plateau states. Kaduna has three senatorial districts; which are the Kaduna North, South and Central senatorial districts and divided into 23 Local Governments. Therefore, two Local Government Areas were selected such as Chikun, Igabi and Kachia Local Government Areas respectively because they represent part of North and South of Kaduna State respectively. The study was carried out in

Chukun forest reserve in two different plantations which include; Pine plantation and Eucalypt plantation while a control site was located adjacent to the plantation areas (Regrowth forest).

III. MATERIALS

The following materials were used to collect samples on the selected plots:

Two ranging Poles, Soil auger, Meter tape, Four surveying pins, Measurement Scale, Linen meter tape, Cutlass, Matchet, Polyethene and Bags.

Experimental design

A Sample plot of 50m x 50m was mapped out and another was done at 200m interval respectively in the study area. Also, 50m x 50m plots were designed in any adjacent regrowth forest as a control. These plantation types are *Eucalyptus specie* and *Pinus carribean*, and forest reserve of a natural rangeland.

Sampling Procedure

The sample plots of 50m x 50m were mapped with the aid of a linen meter tape after taking an edge effect measurement of 25m. Cutlasses and matchets were used for brushing and making transects for the tape. Having done this, a ballot of papers made from 1-50 was tossed without replacement and soil samples were taken at every number chosen from the toss. Soil samples were taken randomly on each plot at 0-20cm and 20-40cm depth at six points with the aid of a soil auger. The various soil samples collected at different depth were weighed each with a constant initial value of 1.5kg using a measurement scale and labeled from S_1 up to S_6. This gave a total of 12 soil samples per plot and 72 samples in the entire study plots. The collected soil samples were labeled in a polythene bag and for oven drying at 40^0C and re-bagged into another polyethene for analysis. This was done in 2 plots in each plantation at different locations of the vegetation area.

IV. DATA ANALYSIS

The soil samples were subjected to evaluations by determining the percentage moisture content of the soils. The data retrieved were analyzed by determining the mean percentage moisture of the samples from the two plots mapped in the plantations and the regrowth forest area. The dry weights of the soil sample were stated using chart.

V. RESULTS

Dry Weight of Sampled Soil in *Eucalyptus camadulensis* Plantation

The data from the field showed in Table 1 that, soil samples total dry weight in *Eucalyptus camadulensis* plantation was highest at the top soil with 6.65kg in plot (B). It was followed by another top soil (0 – 20cm) samples with 6.45kg showing in the second plot (A). In the second depth (20 – 40cm) it was shown that 1.2kg becomes the highest soil sample with the highest value in both plots of *Eucalyptus camadulensis*. Plot A has the lowest dry weight of soil sample which occurs in the depth 20 - 40cm with a value of 0.7kg. It was also shown that in the entire six sample spots in the entire *Eucalyptus camadulensis* study sites, the lowest total dry weight was recorded in plot B at 20 – 40kg depth with 61kg sample weight.

Table 1: Dry Weight of Sampled Soil in *Eucalyptus camadulensis* Plot

	Eucalypt			
	Plot A		**PlotB**	
S/N	**0-20 Mc (S1-S6) Kg**	**20-40 Mc (S1-S6) Kg**	**0-20 Mc (S1-S6) Kg**	**20-40 Mc (S1-S6) Kg**
1	1.2	1.1	1.2	1
2	1.1	1.2	1	1
3	1.1	0.7	1.2	1.1
4	1	1.1	1.24	1.2
5	1.1	1.15	1	1
6	0.95	0.9	1.01	0.8
Total	**6.45**	**6.15**	**6.65**	**6.1**

NB: Wet weight is constant at 1.5kg
Legend: Mc = Moisture Content

4.1.2 Dry Weight of Sampled Soil in *Pinus caribeae* Plantation

Likewise, in Table 2, which was established from result of data recorded in *Pinus caribeae* plantation also with two plots show that plot A has the highest dry weight of sample almost in all the soil sample spots. It was shown to have 1.25kg occurring twice in 20 – 40cm. Also revealed in plot A is the 1.23kg which is next to the highest value from the depth. The lowest soil dry weight sample was recorded also in plot A with the value of 0.95kg and the total low soil sample weight was also found in plot A. Therefore, this makes plot A the plot with the highest total dry weight value with 7.2kg. The lowest total dry weight sample of the entire study site was found in plot B with 6.05kg than other soil samples.

Table 2: Dry Weight of Sampled Soil in *Pinus caribeae* Plot

Pine				
	Plot A		PlotB	
S/N	0-20 Mc (S1-S6) Kg	20-40 Mc (S1-S6) Kg	0-20 Mc (S1-S6) Kg	20-40 Mc (S1-S6) Kg
1	1.05	1.07	1.09	1.2
2	1.1	1.2	1.2	1.15
3	1	1.23	1.2	0.8
4	0.95	1.25	1.2	0.98
5	1	1.2	1.2	1
6	1	1.25	1.1	0.92
Total	**6.1**	**7.2**	**6.99**	**6.05**

NB: Wet weight is constant at 1.5kg
Legend: Mc = Moisture Content

4.1.3 Dry Weight of Sampled Soil in a Regrowth Forest

In the regrowth forest selected adjacent to the two plots serves as a control and it was recorded that plotA has the highest occurring soil sample dry weight of 1.3kg with 1.2kg occurring twice witinn the same plot of the selected study sites. It was also recorded that PlotA has the highest Total soil dry weight value with 6.65kg. PlotB has the lowest record of value showing 0.85kg than the entire selected samples per plot. PlotB also shows the lowest total dry weight of soil samples.

Table 3: Dry Weight of Sampled Soil in *Pinus caribeae* Plot

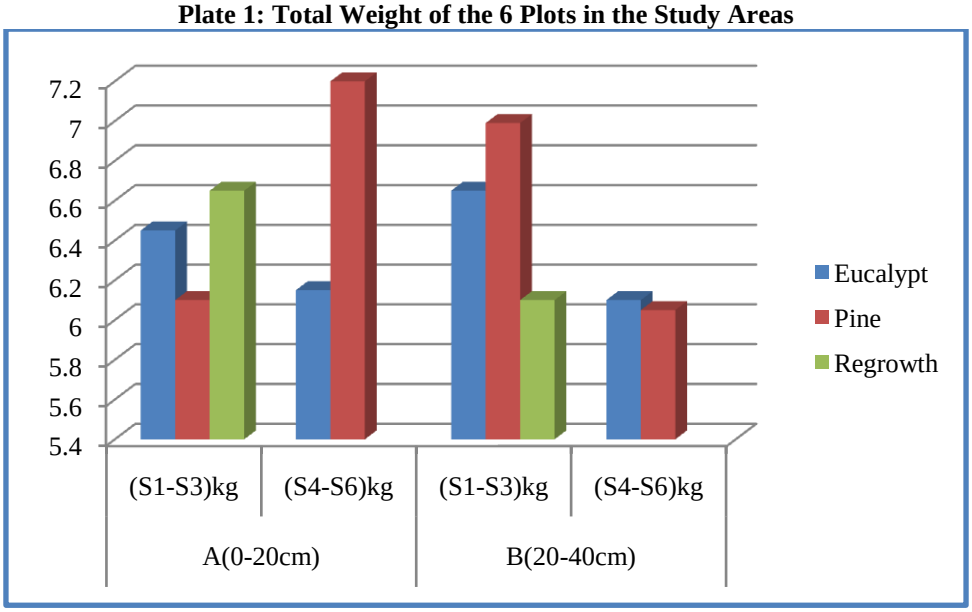
Regrowth		
S/N	A 0-20 Mc (S1-S6) Kg	B 20-40 Mc (S1-S6) Kg
1	1.2	1.1
2	1.2	0.98
3	1	1.02
4	1	1.1
5	1.3	0.85
6	0.95	1.05
Total	**6.65**	**6.1**

NB: Wet weight is constant at 1.5kg
Legend: Mc = Moisture Content

Total Weight of Soil Samples
Total Weight of the 6 Plot in the Study Areas

Plate 1 represents the sum total weight of dry soil samples collected in the entire study locations. It was shown in plate one that among the entire study area, *Pinus caribeae* shows the highest soil dry weight at the lower depth in plot A and topsoil in plot B with recorded values of 7.2kg and 6.99kg than other soil moisture samples in the study area. *Eucalyptus camadulensis* and Regrowth vegetation relatively followed with 6.65kg respectively. Pine plantation still had the lowest dry weight soil sample of 6.05 at the lower depth. It was also noticed that the total soil moisture content at the lower depth (20 – 40cm) of the entire plots showed lower values than most spots.

Plate 1: Total Weight of the 6 Plots in the Study Areas



Legend: S1 – S6 = Spots from which soil samples were collected

Percentage Moisture Content of Soil Samples

In Table 4, the mean percentage moisture content of the 72 soil samples from each spot of soil collection in the entire study plots. It shows that in *Eucalytus camadulensis* plantation has the highest percentage moisture content which was found at the lower soil depth (20 – 40cm) with a value of 73 percent on spot 3. The soil percentage moisture content in spot 6 also at the lower depth (20 – 40cm) followed the highest closely with a recorded value of 70 percent in *Eucalyptus camadulensis* plantation. The lowest soil moisture content was recorded in top soil of plot A of Regrowth vegetation with a value of 17 percent. It was followed closely by plot B spot 4 of *Eucalyptus camadulensis* plantation topsoil with a recorded value of 22 percent.

Table 4: Mean Percentage (Rank) Moisture Content of Soil Samples in the 6 Study Plot of Buruku Plantations

	Eucalypt				Pine				Regrowth	
	Plot A		PlotB		Plot A		PlotB		A	B
S/N	0-20 %Mc	20-40 %Mc	0-20 %Mc	20-40 %Mc	0-20 %Mc	20-40 %Mc	0-20 %Mc	20-40 %Mc	0-20 %Mc	20-40 %Mc
1	25	36	25	50	43	40	38	25	25	36
2	33	27	42	50	38	28	28	29	25	47
3	33	73	25	40	48	25	28	58	42	44
4	42	36	22	30	52	23	28	43	42	36
5	33	32	42	50	48	28	28	42	17	59
6	46	55	41	70	48	23	37	48	46	41

Legend: %Mc = Percentage Moisture Content

The result from the t-Test analysis showed that there is no significant difference in the means sampling compared at both depths (0 – 20cm and 20 – 40cm) showing that P(T<=t) at 0.05 confidence level a value of 0.39.

Soil Weight, Porosity and Capillarity

The values from soil sampling were recorded in Table 4. The weight of oven dry soil, the allowable water percolation and the capillary density were shown in different soil levels (0-20cm and 20-40cm) in *Eucalyptus camamdulensis, Pinus caribeae* and the adjacent regrowth forest.

Table 5: Soil weight, porousity and capillary density in the study area

	Plot Depth (cm)		Weight(kg)	Porosity (ml)	Capillary Density(kg/m^3)
P1	(0-20)	Eucalypt	0.116	45	2.15E-06
	(20-40)	Eucalypt	0.127	46	2.30E-06
P2	(0-20)	Eucalypt	0.119	45	2.20E-06
	(20-40)	Eucalypt	0.103	39	2.20E-06
P3	(0-20)	Eucalypt	0.121	46	2.19E-06
	(20-40)	Eucalypt	0.126	48	2.19E-06
			0.712	**269**	**1.32E-05**
P1	(0-20)	Pine	0.12	44	2.27E-06
	(20-40)	Pine	0.104	43	2.01E-06
P2	(0-20)	Pine	0.11	41	2.68E-06
	(20-40)	Pine	0.122	43	2.83E-06
P3	(0-20)	Pine	0.11	41	2.68E-06
	(20-40)	Pine	0.10	43	2.32E-06
			0.666	**255**	**1.48E-05**
P1	(0-20)	Regrowth	0.12	42	2.86E-06
	(20-40)	Regrowth	0.12	41	2.93E-06
P2	(0-20)	Regrowth	0.11	44	2.08E-06
P3	(20-40)	Regrowth	0.121	47	2.15E-06
	(0-20)	Regrowth	0.11	46	2.40E-06
	(20-40)	Regrowth	0.122	45	2.71E-06
			0.703	**265**	**1.51E-05**

In Table 5, plot samples from *Eucalyptus camadulensis* plantation had the highest soil weight and porosity than those from the other plots (0.712kg and 269ml) while P2 soil sample at 20-40cm had the overall highest soil weight values (0.127kg) in the study area. This was followed closely by P3 soil sample at 20-40cm, which had 0.126kg also from *Eucalyptus camadulensis* plantation. The lowest soil weight and porosity was shown in P2 with a recorded of 0.666kg and 255ml overall soil porosity. The regrowth vegetation subtype showed the highest value in terms of soil capillary density with a recorded value of 1.51E-05kg/m^3 in the study plots. The lowest recorded value of overall capillary density was shown in Eucalyptus vegetation subtype with a value of 1.32E-05kg/m^3 in the study area.

Table 6: Soil bulk samples in the study plots

		Soil Weight (kg)	**Porosity (ml)**	**Capillary Density (kg/m3)**
	Eucalypt(0-20cm)	0.114	41	3.34
	Eucalypt(20-40cm)	0.109	44	2.97
	Pine(0-20cm)	0.118	46	3.08
	Pine(20-40cm)	0.112	45	2.99
	Regrowth(0-20cm)	0.114	43	3.18
	Regrowth(20-40cm)	0.111	43	3.12

In Table 6, it was shown that Pine vegetation subtype had the highest soil bulk weight at the topsoil (0-20cm) with 0.118kg, followed by Eucalypt and Regrowth vegetation subtype which had respective values of 0.114kg topsoil bulk weight in the study plots. The lowest soil bulk weight was seen in Eucalypt soil samples with a recorded value of 0.109kg at the subsoil (20-40cm), which was followed by 0.111kg recorded from the regrowth bulk soil samples at the subsoil.

Bulk soil porosity was highest in the two Pine bulk samples with recorded value of 46 ml and 45 ml at both soil depths (0-20cm and 20-40cm) while the lowest was recorded in Eucalypt bulk soil sample at the subsoil (0-20cm) with a recorded value of 41. Regrowth vegetation soil samples recorded the values of 43ml respectively.

The capillary density of bulk soil sample was shown to have a high value in Eucalypt vegetation subtype with a recorded value of 3.34kg/m^3 at 0-20 cm soil depth. This was followed by 3.18 kg/m^3 also at the topsoil from Regrowth vegetation subtype. The lowest bulk soil sample capillary density was recorded in Eucalypt vegetation subtype with recorded values of 2.97ml at the subsoil which was closely followed by Pine vegetation subtype with a recorded value of 2.99ml also at the subsoil.

There was no significant relationship between the individual soil weight and bulk weight of soil samples from the study area as values recorded from the F-test soil analysis at 0.05 degree of freedom returned a non significant value of 5.61. Also, the t-Test of Pearson correlation revealed there was no significant different between the soil weight and the capillary density of the soil samples inventoried at 0.05 degree of freedom returning a value of 2.13 and 2.77 also at both tails of the critical values. It was further shown that there is a significant difference between soil weight and porosity in the study plots returning critical values (4.2E-13) less than the degree of freedom (0.05).

VI. DISCUSSION

All the results from the 6 plots selected have shown that the topsoil have the highest density of soil dry weight as it was shown in Plate 1. This supports similar findings by Boone *et al*. 1998; Buchmann 2000; Hanson *et al*. 2000; that the soil organic matter are determinant mechanisms for respiration around plant root therefore, increasing the biomass of the topsoil from activities of organic decay. The highest percentage soil moisture content in Eucalypt plantation (73% and 70%) may also be attributed to enhanced soil infiltration (van de Koppel, 1997). This also agrees with the findings of Adams and Attiwill, 1986 that biomass of Eucalypt may take more time in its decomposition processes which also inhibit the decomposition of biomass of other nature.
Also, in the entire plots and spots, the percentage moisture content in the regrowth returned the lowest value (57%) than others in the study plots. Walker *et al*., 1981; Greene, 1992; Greene et al., 1994, 2001; Breman and Kessler, 1995; Scholes and Archer, 1997, Bhark and Small, 2003; Zeng and Zeng, 1996; Zeng *et al*., 2004 indicated that subcanopy soils are frequently found to be moister than intercanopy patches, suggesting the possible existence of a positive feedback between vegetation and soil water content. Vegetation–soil moisture feedback has important implications for dryland ecosystems in that it may lead to pattern formation (Lefever and Lejeune, 1997; von Hardenberg *et al*., 2001; Hillerislambers *et al*., 2001). Lejeune *et al*., 2002 recognize that the moister subcanopy environment facilitates seedling establishment beneath the canopy of existing plants (e.g., Scholes and Archer, 1997; Caylor *et al*., 2003), while the exploitation of soil water resources by competing lateral root systems makes intercanopy patches unsuitable for vegetation establishment and growth (Casper et al., 2003).

Associated with all the plantations, it was observed there is no significant effect on soil porosity in the study plots. This could be as a result of moisture uptake in plantation soil over pacing the rate of supply or decrease in hydrological pathway (Jackson *et al*., 2005). Redistribution of mineral soil cation from soil to biomass pools is commonly observed in the savannah plantation soil (Jobbagy and Jackson, 2003; Ouro *et al*., 2001).

VII. CONCLUSION

The results revealed that undisturbed forest types have higher weight and moisture content of soil than the plantation types although it tested that there is no significance in their differences. The soil sampling also shows that the soil vegetation in the study areas low retentive capacity as only few has up to 50% soil moisture. The outcome of the result from the plantation shows more relevance to developmental strategy. This showed that soil weight or mass is higher at the soil base than it is at the top soil. It reviews the recuperation and revitalization of the plantation soil over a period of, creating diversity of flora and fauna from different litter inoculation in the soil and reducing adverse ecological interactions.

RECOMMENDATION

The recommendation relates to existing inferences that provide adequate blueprint to basic environmental protection through regeneration processes. Soil moisture should always be considered in different land management programs. In establishment of forests and farms, moisture content can contribute to nutrient gain or loss as it is a basic requirement of plant growth.

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