African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 173-184)
www.abjournals.org

AGGREGATE STABILITY INDICES OF A TYPIC HAPLUDULT UNDER DIFFERENT LAND-USE TYPES AND VARYING DEPTHS AT UMUAHIA

Amanze C. T.[1*], Ibe O. K.[2], Nwosu O. C.[3], Okoror P. I.[4],

Ukabiala M. E.[1], and Eluagu K. F.[5]

[1]Department of Soil Science, University of Agriculture and Environmental Sciences, Umuagwo, Imo State, Nigeria.

[2]Claretian University of Nigeria, Maryland Nekede, Owerri, Imo State.

[3]Department of Soil Science and Meteorology, Michael Okpara University of Agriculture, Umudike P.M.B 7267 Umuahia, Abia State, Nigeria.

[4]Department of Agronomy and Environmental Management, Faculty of Agriculture and Agricultural Technology. Benson Idahosa University, Benin City, Edo State, Nigeria.

[5]Federal College of Agriculture Isiagu, Ebonyi State, Nigeria.

[*]Corresponding Author's Email: chikamneleamanze@gmail.com

Cite this article:

Amanze, C. T., Ibe, O. K., Nwosu, O. C., Okoror, P. I., Ukabiala, M. E., Eluagu, K. F. (2024), Aggregate Stability Indices of a Typic Hapludult under Different Land-Use Types and Varying Depths at Umuahia. African Journal of Environment and Natural Science Research 7(3), 173-184. DOI: 10.52589/AJENSR-XHAYSJCR

Manuscript History

Received: 19 Jun 2024

Accepted: 7 Aug 2024

Published: 16 Aug 2024

ABSTRACT: *Soil aggregates stability is among the soil conditions influencing the fertility and quality of soils. This study was carried out to assess the implications of land-use practices and soil depths on aggregate stability indices. It was split-plot experiment in Randomized Complete Block Design (RCBD) with factors as; land-use practices (main-plot factor) and soil depths (subplot factor). The land-use practices were of four levels {continuously cultivated land (CC), forest land (FL), grassland (GL), and oil palm plantation (OP)}; while soil depths were of five levels (0 – 20, 20 – 40, 40 – 60, 60 – 80, 80 – 100 cm). Treatment combinations were replicated nine (9) times such that (9) mini-pits of 100 cm each were randomly dug in the respective land-use, then disturbed and undisturbed soil samples were collected from specified depths.. Data generated from laboratory analyses were subjected to analysis of variance (ANOVA) using GenStat version 15. Results showed that there was significant ($P \leq$ 5%) difference in aggregate stability indices among the land-use practices and across the depths; also there was significant ($P \leq 5\%$) interaction between land-use practices and depths. The highest dispersion index of 29.48 % was observed under the FL at 0 – 20 cm depth, while the highest clay dispersion index of 42.31 % was observed under GL at 0 – 20 cm depth. Aggregated silt + clay increased with an increase in depth with GL having the highest value of 29.98 % at the 80 – 100 cm depth. The highest and lowest clay flocculation indices were observed at the CC and GL across the depths, respectively. The highest mean weight diameter across the depths was observed at the OP while CC had the lowest across depths. Therefore, aggregate stability indices vary across soils of different land-use practices and depths; hence should be considered in soil management decisions.*

KEYWORDS: Aggregate stability, land-use, soil depth, micro aggregate, macro aggregate.

INTRODUCTION

Soil aggregation and the stability of the aggregates account for most physical, chemical and biological conditions of soils including soil porosity, bulk density, permeability, erodibility and water retention (Nathalie, 2014). These soil parameters in turn influence soil productivity and quality (Nathalie, 2014). Six et al. (2000) explained that soil aggregate stability is a basic structural property of soil which conditions soil productivity as well as its resistance to erosion and degradation. It serves as an indicator of soil structural quality because of its influence on carbon stabilization, soil porosity, hydraulic properties of soil and its resistance to water erosion and overland flow (Raine and So, 1997; Canasveras et al; 2010).

The aggregation and the stability of aggregates are influenced by some intrinsic and extrinsic properties of soil including soil organic matter, biodiversity and bio-activities which are influenced by land-use practices, clay content and mineralogy, concentration of sesquioxides, etc. (Dilip, 2012). Nwite (2015) reported that intensive cultivation of soil resulted in increased damage of macro aggregates though it enhanced soil infiltration capacity and permeability. On the other hand, glass land and forest soil were reported for increased stability of soil aggregates at micro and macro levels compared to the cultivated arable soils (Dilip, 2012). Furthermore, soils under dense vegetation cover for an extended period of time had modified microclimate which promoted organic matter storage and biomass activities which enhanced soil aggregation and stability of aggregates thereby improving soil structure (Mbagwu and Auerswald, 1999; Amanze et al., 2017). The findings of Senjobi (2007) showed that changes in land-use and management practices influenced soil aggregation such that bush burning, intensive cultivation and other tillage-related practices increased the loss of soil aggregate stability resulting in soil structural degradation. Also, continuous cultivation resulted in a high sand fraction which weakened the stability of macro aggregates (Malgwi and Abu, 2011). Also, Amanze et al. (2022) highlighted that the use of heavy machines in tillage operation can increase the bulk density which enhances the stability of micro aggregates. Land-use practices which are capable of decreasing soil organic matter storage were noted for their potential to increase the stability of micro aggregates considering that such soils retain more clay particles which correlates positively with micro aggregates stability (Amanze et al., 2023).

Most reports on the variation of aggregate stability indices across land-use types were based on observations made at the topsoil; hence, there is a dearth of information on the extent of such variation at higher depths. Therefore, the objective of this study is to ascertain the variation in soil aggregate stability indices across selected land-use practices at varying depths.

 Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 173-184)
www.abjournals.org

MATERIALS AND METHODS

Location and description of the study area

The study was conducted at Umuahia, Abia State. The area lies within latitude $5^{0}29^{l}$N to $5^{0}31^{l}$N and longitude $7^{0}30^{l}$E to $7^{0}32^{l}$E with a mean annual rainfall distribution of 2200 mm (Amanze et al., 2022). The area is characterized by rainy and dry seasons. The rainy season starts in March and extends to early November with bimodal peaks in July and September. The dry season starts in November and lasts till February. The mean annual temperature is about 28^{0}C (Amanze et al., 2022). The landscape is levelled to gently undulate with coastal plain sands as the parent material. The soil of the area is of the great group "Hapludult" according to the USDA soil taxonomy, and the clay minerals are dominated by Kaolinite (Soil Survey Staff, 2010 and Amanze et al., 2016).

Land-use types

The study involved four land-use types which are; continuously cultivated arable farmland (CC), oil palm plantation (OP), forest land (FL) and grassland (GL). The forest land was secondary vegetation growing for over 20 years with such plant species as oil bean plant (*Pentaclethra macrophyllum*), African breadfruit (*Treculia Africana*), and bush mango (*Irvingia gabonensis*). Other plant species growing in the forest land were shrubs and herbs like "Siam weed" (*Eupatorium odoratum*), etc. The forest land covered a geographical area of 05^{0} 29'12.1''N to 05^{0}29' 11.5''N and 07^{0}32'38.2''E to 07^{0}32'39.9''E. The grassland was a 3-year grass fallow land previously cultivated to cassava in which the tillage operations were by the use of plough, harrow and ridge attached to a tractor. The grass species was predominantly elephant grass (*Panicum maximum*) and a few other types of grass like spear grass (*Imperata cylinderica*), carpet grass (*Axonopus compressus*), etc. The grassland covered a geographical space of 05^{0}29'38.1''N to 05^{0}29' 42.2''N and 07^{0}32' 29.2''E to 07^{0}32'30.4''E. The oil palm plantation was established for over 20 years. There were also other plant species growing on the plantation as weeds such as "Siam weed" (*Chromoleana odorata*), mimosa plant (*Mimosa pudica*), etc. However, the weeds were periodically cleared especially during the dry season to reduce competition with the oil palm trees. The oil palm plantation had a geographical coverage of 05^{0}31' 37.6''N to 05^{0}31' 37.2''N and 07^{0} 30' 27.7''E to 07^{0}30' 26.7''E. The continuously cultivated arable farmland was planted with cassava (*Manihot esculentus*), yam (*Dioscorea spp.*) and pumpkin (*Telferia occidentalis*). The soil fertility was managed by the application of both mineral (NPK) and organic fertilizers (poultry droppings and swine waste) while weeds were managed by manual method of hoeing and hand-picking. Continuously cultivated arable farmland had a geographical coverage of 05^{0}31' 40.2''N to 05^{0}31' 42.3''N and; 07^{0} 30' 35.2''E to 07^{0} 30' 34.4''E. Organic carbon storage of the soils at the land-use practices varied such that the mean values across the depths were obtained as 14.22, 25.41, 19.68 and 25.74 tons/ha for CC, FL, GL and OP, respectively (Amanze et al., 2022). Also, the land-use practices varied in clay content such that the mean clay content across the depths were 193.9, 105.7, 145.8, and 208.2 for CC, FL, GL and OP, respectively (Amanze et al., 2022).

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

Soil sampling

Nine (9) representative mini-pits of 100cm depth were randomly dug in each land-use type. The pits were delineated into five depths of 0 – 20 cm, 20 – 40 cm, 40 – 60 cm, 60 – 80 cm and 80 – 100 cm. Disturbed soil samples were collected from each depth which gave a total of forty - five disturbed soil samples in each land-use type. Therefore, a total of one hundred and eighty (180) disturbed soil samples (4 land-use x 5 depths x 9 replicates) were collected across the land-use types.

Sample preparation

The disturbed soil samples were air–dried and divided into two portions such that one portion was passed through a 2 mm sieve for particle size distribution and the other portion was used for the determination of water-stable aggregates.

Laboratory analyses

The soil samples were analysed for particle size distribution and aggregate stability indices as follows:

Particle size distribution: This was determined using the hydrometer method as described by Gee and Or (2002).

Microaggregate stability: This was determined using the amount of silt and clay in calgon–dispersed as well as water–dispersed samples during particle size analysis described by Gee and Or (2002). Hence, the various micro aggregate stability indices were calculated thus:

$$\% \; Dispersion \; ratio = \frac{\%[Silt + Clay(H2O)]}{\%[Silt + Clay(calgon)]} \; X \; 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. Eq \; 1$$

$$\% \text{ Aggregated Silt } + \text{ Clay} = \%[\text{Silt } + \text{ Clay(calgon)}] - \%[\text{Silt } + \text{ Clay(H2O)}]\ldots\ldots \text{Eq. 2}$$

$$\% Clay \; flocculation \; index \; (CFI) \; = \frac{\%Clay(calgon) - \% \; Clay(H2O)}{\% \; Clay(calgon} \; X \; 100 \ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. 3}$$

$$\% Clay \; dispersion \; index \; (CDI \; = \frac{\% \; Clay \; (H2O)}{\%Clay \; (calgon)} \; X \; 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq.4}$$

The mean weight diameter (MWD) of Water water-stable aggregates (WSA) was obtained through the wet-sieving method outlined in Kemper and Rosenau (1986) by first analysing the soils for water-stable aggregates of varying sizes. Then, the mean weight diameter (MWD) of the water-stable aggregates was calculated using the formula shown below:

$$\text{MWD} \; = \; \sum_{i=1}^{n} XiWi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. 5}$$

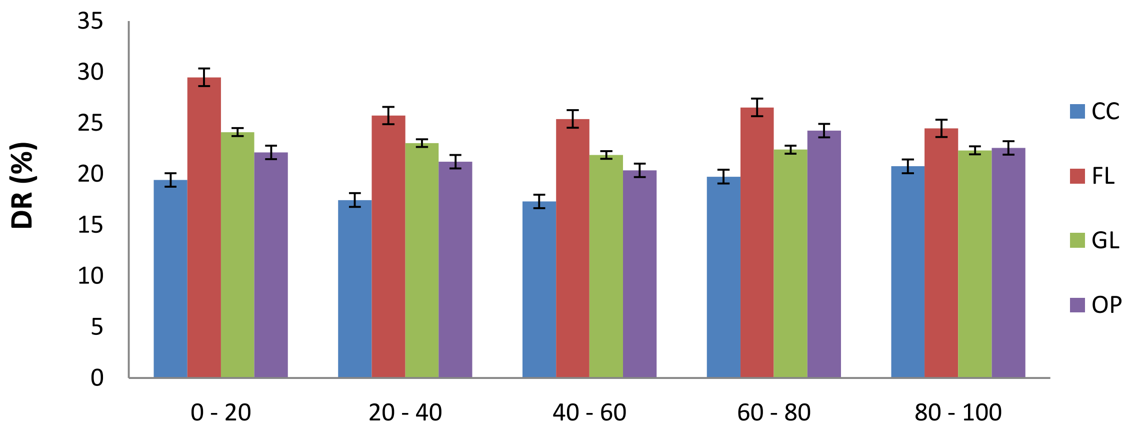
Where Xi is the mean diameter of the ith sieve and Wi is the proportion of the weight of aggregates in the ith sieve.

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

RESULTS AND DISCUSSION

Dispersion ratio and clay dispersion index

Figures 1a and 1b show the dispersion ratio (DR) and clay dispersion index (CDI) across the land-use types and depths. Figure 1a showed a significant interaction (P≤0.05) of land-use type and depth in influencing DR as well as variation in DR with depths under each land-use type. The lowest values of 19.41 %, 17.44 %, 17.31 %, 19.74 % and 20.75 % at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm, respectively, were observed under CC. The highest values were observed at FL (29.4 8%, 25.73 %, 25.39 %, 26.52 % and 24.47 %) for 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm, respectively. These values for CC and FL were significantly (P≤0.05) different from the other land-use types at the respective depths. In comparing the various depths at each land-use type, the results showed that there was a general decrease in the values of DR as depth increased. However, under CC and OP, there was a significant increase at 60-80 cm and 80-100 cm. Under FL, there was a significant difference between the value (29.48 %) at 0-20 cm depth and the residing depths.



LSD(0.05): LxD = 2.36, Depth = 2.17 **Depth(cm)**

Fig. 1a: Effect of land-ude practices and depths on Dispersion ratio (DR)

As shown in Fig. 1b, land-use and depth interacted significantly (P≤0.05) to influence CDI. There was also a significant variation from one depth to another under each land-use type The highest values of 42.33 %, 40.97 %, 36.74 %, 37.45 % and 33.34 % at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm, respectively, were observed at GL, which was significantly different from the other land-use types, but at 0-20 cm depth there was no significant difference between FL and OP. Lowest values of CDI at all the depths were observed under CC and these were significantly different from the other land-use types. However, OP was not significantly different from CC at 40-60 cm and 80-100 cm depths, respectively. Comparing the variation in depths under each land-use type, the results showed that there was a general decrease in CDI with an increase in depth. Under CC, the value of 25 % was observed at 0-20 cm depth, which was significantly different from other depths but was not significantly different from 20-40 cm depth. There was no significant difference between 20-40 cm and 80-100 cm depths. Under FL, the highest value of 39.55 % was observed at 0-20 cm depth which was significantly different from the other depths. The lowest value of 26.12 % was observed at 80-100 cm depth, which was significantly different

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

from the other depths but was not significantly different from 40-60 cm and 60-80 cm depths. Under GL, the highest value of 42.33 % was observed at 0 – 20 cm, which varied significantly from other depths but did not differ statistically from 20-40 cm depth. The lowest value of 33.34 % was observed at 80-100 cm, which was significantly different from others. The highest value of 33.94 % was observed under OP at 0-20 cm depth, which differed significantly from other depths whereas the lowest value of 20.43 % was observed at 80-100 cm depth, which varied significantly from the other depths.

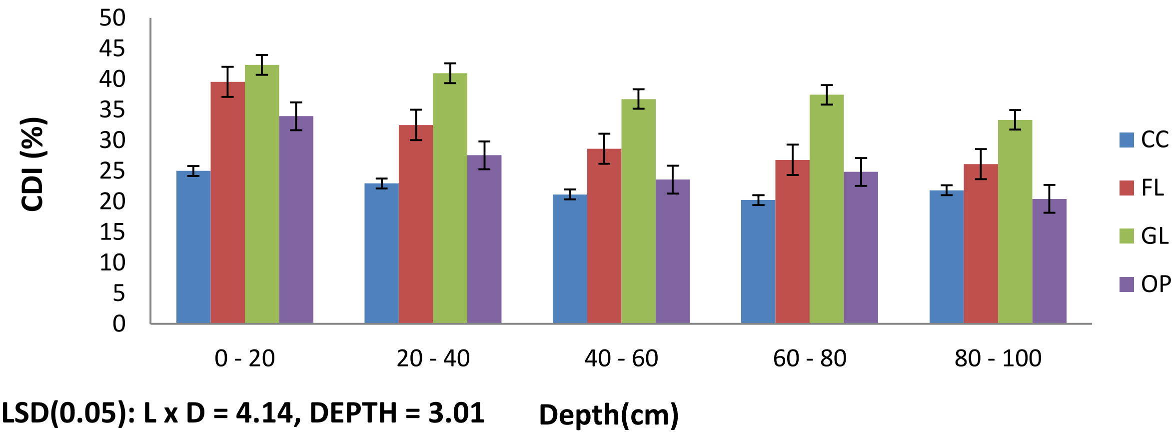


Fig. 1b: Effect of land-use practices and depths on clay dispersion index (CDI)

The classification of soils based on their degree of dispersivity by Elges (1985) showed that these soils were little dispersed, and this could be attributed to the clay mineralogy of the soils being dominated by Kaolinite, a 1:1 clay mineral (Lekwa and Whiteside, 1986), which has little or no expansion and contraction property because of its limited interlayer space. This, therefore, helped to eliminate or reduce the dispersive action of entrapped air and water within the interlayer space as common with the 2:1 expanding clay minerals (Elges, 1985). This assertion affirmed the finding of Le Bissonnais (1996) who reported that physicochemical dispersion will be affected by clay mineralogy, ionic composition and concentration. However, the relatively high degree of dispersion observed under FL and GL compared to OP and CC was probably a result of their high sand and silt fractions with low clay content as well as relatively high OC content which probably contained polyanionic humic substances that may have increased the net negative charge within the colloidal mixture thereby encouraging the dispersion of the clay particles (Stevenson, 1992). On the contrary, the relatively low dispersion observed under CC compared to other land-use practices could be a result of its high clay content and low OC. This observation supported the findings of Stevenson (1992) and Nelson and Oades (1998) who reported that high OC compounds increased the net negative charge of the soil colloidal mixture thereby interfering with the negatively charged surfaces of clay particles which results in an increased dispersion of clay particles by repulsive actions. Also, Uddivira and Camps (2006) and Amanze et al., (2017) reported that soil aggregation and aggregate stability at the micro-level increased with an increase in clay content. This implies that the relatively high clay content dominated by kaolinite, a non-expanding clay mineral, at CC, may have contributed to its reduced dispersion (Lekwa and Whiteside, 1986). Consequently, the increase in the resistance of the soil to dispersion at higher depths could be related to the increase in clay content and possibly

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

the increased presence of polyvalent cations (such as Al^{3+}) as well as a reduction in OC with depth (Uddivira and Camps, 2006).

Aggregated silt + clay

Figure 2 below shows the aggregated silt + clay (ASC) across the land-use types and depths. The figure indicated that there was a significant (P≤0.05) interaction between land-use types and depths as well as significant (P≤0.05) variations across depths in each land-use type. The highest value of 19.98 % was observed under CC at 0-20 cm depth, which differed significantly from the other land-use types except GL. The order of increase in ASC at 0 -20 cm depth was CC > GL > OP > FL. At 20-40cm depth, the highest value of 22.76 % was also observed under CC, which was statistically similar to GL and OP but different from FL. At 40-60 cm depth, the highest value of 25.44 % was observed under GL, which differed significantly from the other land-use types except CC. At 60-80 cm depth, the highest value of 26.67 % was also observed under GL, which varied significantly from the other land-use types while CC and OP were statistically similar at this depth. At 80-100 cm depth, the highest value of 29.98 % was observed under GL, which was significantly different from the other land-use types but OP. Among land-use types, FL had the lowest values across the respective depths, and these values showed significant variation from the other land-use types while GL had the highest values of ASC which were not significantly different from CC at 0-20 cm, 20-40 cm and 40-60 cm.

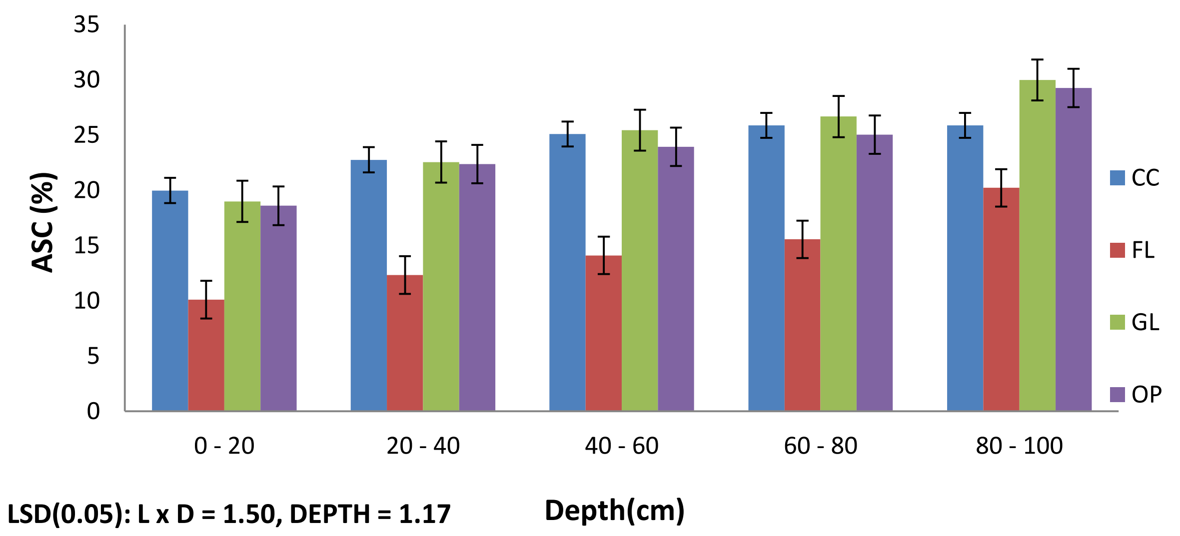


Fig. 2: Effect of land-use practices and depths on aggregated silt + clay (ASC)

The weak aggregated silt + clay (ASC) observed at FL could be predicated on its low clay and silt contents, and high sand fraction (Nelson and Oades, 1998). Clay particles are considered as cementing agents of aggregation because of their high specific surface area, and high physical and chemical activities (Canasveras *et al.*, 2010). This therefore explained the reason for the increase in ASC at CC and at the residing depths due to their high clay content. Meanwhile, the greatest stability of aggregated silt + clay at GL could be a result of

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

the compaction of the soil by the overburden effect caused by the use of heavy machinery in the tillage operation (Kutilek, 2005)

Clay flocculation index

The values of the clay flocculation index (CFI) across the land-use types and depths are shown in Figure 3. There was a significant (P≤0.05) interaction between the land-use types and depths. It was observed that at all the depths, the highest values of 75.00 %, 77.04 %, 78.83 %, 79.21 % and 78.16 % were observed under CC which was significantly (P≤0.05) different from those of the other land-use types at the respective depths except at 40-60 cm and 80-100 cm depths where it was not significantly different from OP. The lowest values of 57.67 %, 59.91 %, 63.26 %, 61.92 % and 66.66% were observed under GL at the respective depths from top to bottom, which differed significantly from the other land-use types. When values across the depths under each land-use type were compared, there was a general increase in CFI with an increase in depth indicating better aggregation at the colloidal level with depth. Under CC, the lowest value of 75.00 % was observed at 0-20 cm depth which significantly differed from the other depths except for 20-40 cm depth. Under FL, the lowest value of 60.45 % was observed at 0 – 20 cm depth and this varied significantly from the other depths. Under GL, 0-20 cm depth had the lowest value of 57.67 % which was not statistically different from 20-40 cm and 60-80 cm depths. Under OP, the lowest value of 66.06 % was observed at 0-20 cm depth which was significantly different from other depths.

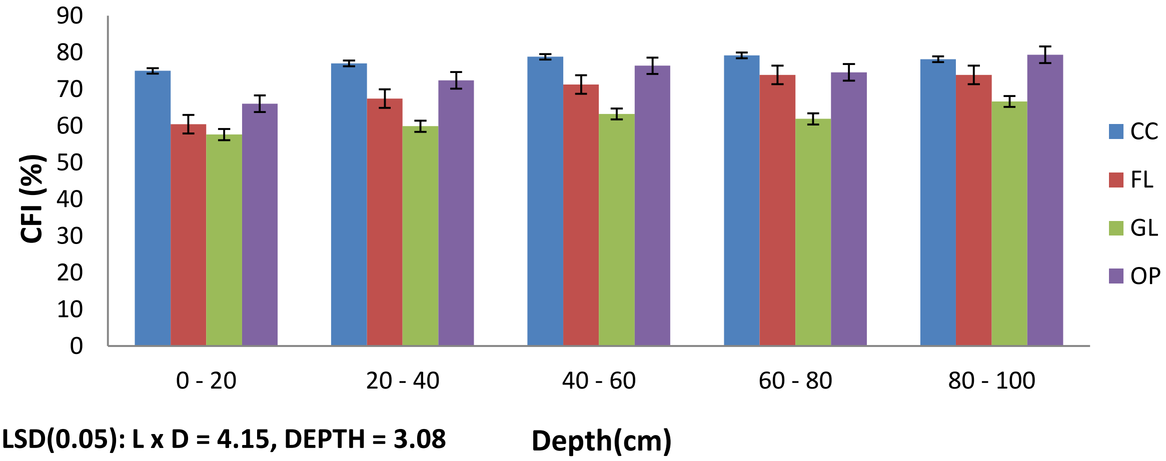


Fig. 3: Effect of land-use practices and depth on clay flocculation index (CFI)

The high clay flocculation index (CFI) observed at CC may be due to its high clay content and reduced OC. The report of Goldberg and Forster (1990) stated that an increase in OC increased the critical flocculation concentration (CFC) of soils which resulted in increased dispersion and by implication reduced the flocculation of clay particles. This implies that the low OC content under CC promoted clay flocculation (Frenkel *et al.*, 1992). Conversely, the reduced clay flocculation at OP irrespective of its high clay content was due to its high OC content which rather increased the CFC of the soil and promoted the dispersivity of clay particles (Goldberg and Forster, 1990). In line with this report, the general increase in CFI with an increase in depth could be attributed to an increase in clay content and a decrease in OC at higher depths (Uddivira and Camps, 2006).

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 173-184)
www.abjournals.org

Mean weight diameter

Figure 4 revealed a significant interaction of land-use type and depth in influencing MWD. At all depths, OP had the highest values of 1.33, 1.24, 1.05, 0.90 and 0.84 mm for 0-20, 20-40, 40-60, 60-80 and 80-100 cm depths, respectively. Oil palm plantation (OP) was significantly (P≤0.05) different from the other land-use types at all depths except at 80-100cm depth where it was not significantly different from GL. Glassland (GL) had the lowest value of 0.86 mm at 0-20 cm and this was not significantly different from CC (0.87 mm) at the same depth. The lowest values of 0.74, 0.68, 0.64 and 0.60 mm at 20-40, 40-60, 60-80 and 80-100 cm depths, respectively, were observed under CC. These were not significantly different from those of FL across the respective depths but differed significantly from GL at 40 – 60, 60 – 80 and 80 – 100 cm depths. The figure further revealed a significant variation across depths under each land-use. In all the land-use types, MWD was observed to be decreasing with an increase in depth. Under CC, FL and OP, the highest values of 0.87, 0.95 and 1.33 mm, respectively, were observed at 0-20 cm depth and these differed significantly from the other depths under these land-use types. Under GL, the highest value of 0.86mm was observed at 0-20 cm depth, which was not significantly different from the other depths.

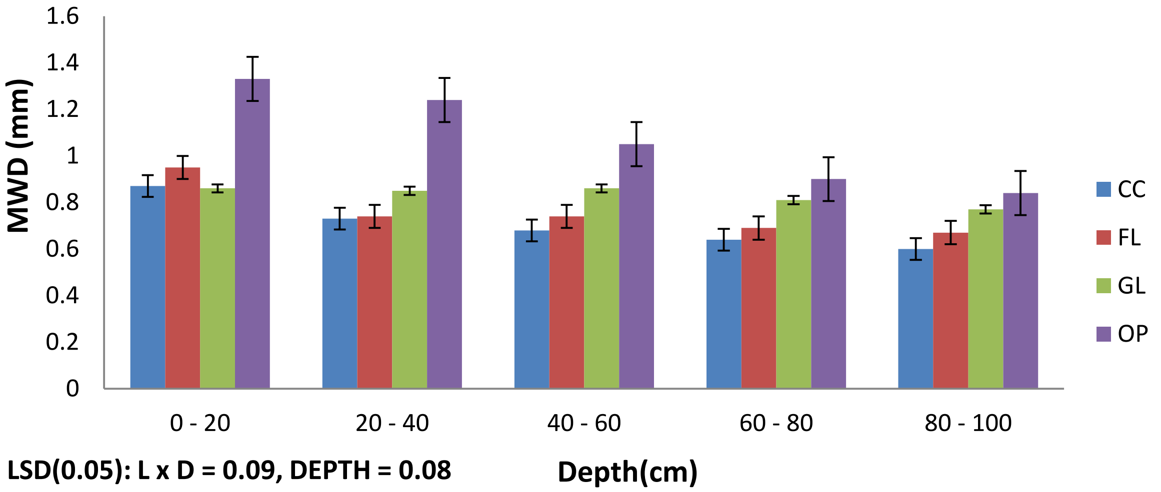


Fig. 4: Effect of land-use practices and depth on mean weight diameter (MWD) (mm)

The relatively high value of MWD at OP and GL could be related to the flocculation of micro aggregates into macro aggregates possibly by the binding actions of the polysaccharides exuded from the decomposing OM and plant roots. There may also be the influence of fungi hyphae that formed associations with the roots of higher plants at OP while the high fibrous root density of the grasses at GL helped in enmeshing the soil particles into stable macro aggregates. This observation agrees with Golchin *et al.* (1995) who reported that MWD, which is a measure of macro aggregate stability, was improved mainly by carbohydrate-rich roots or plant debris occluded within aggregates. The general decrease in MWD down the depth could be attributed to the decrease in polysaccharides (passive Organic matter), root density and fungi hyphae as depth increased supported by the report of Golchin *et al.* (1995).

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

CONCLUSION

Aggregate stability indices vary across soils of different land-use practices and depths such that land-use practices that promote the accumulation of organic carbon such as FL and OP had weak stability of micro aggregates but promoted stability of macro aggregates while land-use practices that are associated with low organic carbon content and increased clay content such as the CC had better stability of micro aggregates but weak macro aggregates. Macro aggregation and stability of macro aggregates decrease with an increase in depth while micro aggregation and stability of micro aggregates increase with an increase in depth. There is a need to improve the organic carbon status of the continuously cultivated soil through extraneous input of organic manure to promote the stability of its macro aggregates for better soil quality and productivity. The use of soils of high organic carbon content in civil engineering works should be discouraged as it may result in structural failure and collapse of constructed works.

Declaration

We hereby declare as follows;

That ethical approval and consent to participate are not applicable in this research.

That consent to publish is not applicable to this work.

The dataset generated and/or analysed during the current study is available from the corresponding author upon reasonable request.

That the authors have no competing interest.

The study was self-funded.

We sincerely acknowledge Chibueze Nwangwu of the Department of Soil Science (Laboratory Unit), National Root Crops Research Institute, Umudike, Nigeria, for his assistance in analysing the soil samples in the laboratory.

REFERENCES

Amanze C. T., Eneje R. C., Oguike P. C., Ukabiala M. E., Nwosu O. and Onyechere A. U. (2023). Vertical Changes of Organic Carbon Storage, Structural and Hydraulic Properties of a Humid Tropical Soil under Vegetation Cover in Southeast Nigeria. *Asian Soil Res. Journal.*, 7(4), 12-19

Amanze, C. T., Oguike, P. C., Eneje, R. C., Ukabiala, M.E., Omatule, L.A., Ozomata, A.S, Kolo J., Nwosu, O. C. (2022). Organic Carbon in relation to Water Retention Characteristics of a Typic Hapludult under four land use types at Ndume Ibeku in Southeastern Nigeria. *International Journal of Agric. and Rural Development.* 25(2), 6512–6517.

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

Amanze, C. T., Oguike, P. C. and Eneje, R. C. (2017). Land use effect on some Physicochemical properties of Ultisol at Ndume Ibeku, Southeastern Nigeria. *International Journal of Scientific and Research Publication*. 7(9), 2250 – 3153

Amanze, C. T, Oguike, P. C and Lekwa, G. (2016). Characterization and Classification of Soils at Mbara Achara Ubowalla, Emekuku in Owerri North LGA, Imo State. *Nigeria Journal of Soil and Environmental Research*. 14(1), 245 – 255

Canasveras, J. C., Barron, V., Del Campillo, M. C., Torrent, J. and Gomez, J. A. (2010). Estimation of aggregate stability indices in Mediterranean soils by diffuse reflectance spectroscopy. *Geoderma*, 158: 78 – 84.

Dilip, K. D. (2012). Introductory to Soil Science, kalyani Publishers Pp 49 - 57

Elges, H. F. W. K. (1985). Problem soils in South Africa – state of the Art. The civil engineer in South Africa, 27: 347 – 353.

Frenkel, H., Fey, M. V. and Levy, G. J. (1992). Organic and inorganic anions effects on reference critical flocculation concentration. *Soil Sci. Soc. Am. Journal* 56: 1762 – 1766.

Gee, G.W. and Or, D. (2002). Particle Size Analysis. In method of Soil Analysis, Physical Methods, Dane, J. H. and G. C Topp (Eds). ASA and SSSA Madison, W. I., Pp: 255 – 293.

Golchin, A., Oades, J.M., Skjemstad, J.O. and Clarke, P. (1995). Structural and dynamic properties of soil organic matter as reflected by 13C natural abundance, pyrolysis mass spectrometry and solid-state 13C NMR spectroscopy in density fractions of an oxisol under forest and pasture. *Australian Journal of Soil Research* 33 (1), 59–76.

Goldberg, S. and Forster, H.S. (1990). Flocculation of reference clays and arid – zone soil clays. *Soil Sci. Soc. Am. Journal* 54: 714 – 718.

Kemper W. D. and Rosenau, R. C. (1986). Size Distribution of Aggregates. In: Methods of Soil Analysis, A. Klute (Ed.) part I. 2nd Edn. Agron. Mongr. 9. ASA – SSSA, Madison, W.I., Pp. 425–442.

Kutilek, M. (2005). Change of Soil Porous system due to Landuse. Unpublished lecture notes. College of soil Physics, International Centre for Theoritical Physics, trieste, Italy.

Le Bissonnais, Y. (1996). Aggregate stability and assessment of soil crustability and erodibility.. Theory and methodology. *Euro. Journal soil sci*. 47: 425 - 437

Lekwa, G. and Whiteside, E.P. (1986). Coastal Plain sand of South Eastern Nigeria; Morphology, Classification and genetic Relationship. *SSSA Journal* 50: 154 – 160

Malgwi, W. B. and Abu, S. T. (2011). Variation in some Physical properties of Soils formed on a hilly terrain under different landuse types in Nigeria savanna. *International Journal of Soil Science*, 6: 150 – 163.

Mbagwu, J.S.C. and Auerswald, K. (1999). Relationship of percolation Stability of Soil Aggregates to Landuse, selected properties, Structural indices and simulated rainfall erosion. *Soil Tillage Resources*, 50: 197 – 206.

Nathalie S. (2014). What is soil structure and why is it important. deepRoot Blog.

Nelson, P. N. and Oades, J. M. (1998). Organic matter, sodicity and soil structure. Pp. 67 – 91. In Summer, M. E. and Naidu, R., (eds) sodic soils. Oxford Univer. Press, New York.

Nwite, J. N. (2015). Assessment of soil structural stability under different landuses using some predictive indices in Abakaliki Southeastern Nigeria. *Curr. Agric. Res.* 3: 1 – 3.

Raine, S.R. and So, H.B. (1997). An investigation of the relationships between dispersion, power, and mechanical energy using the end-over-end shaking and ultrasonic 232 S. An

Article DOI: 10.52589/AJENSR-XHAYSJCR
DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR

et al. / Catena 81 (2010) 226–233 methods of aggregate stability assessment. *Australian Journal of Soil Research* 35:41–53.

Senjobi, B. A., Adeokun, O. A., Dada, O.A. and Ogunkunle, A. O. (2007). Influence of traditional farming practices on soil productive potentials in Ago – Iwoye enclave, Ogun State, Nigeria. J. Environ. Extension, 6: 64 – 70.

Six, J., Elliot, E.T.and Paustian, K. (2000). Soil macroaggregate turnover and microaggregate formation: a mechanism for C sequestration under no-tillage agriculture. *Soil Biology & Biochemistry* 32, 2099–2103.

Stevenson, F. J. (1992). Humus chemistry: genesis, composition and reactions. 2nd edn. John Wiley and sons, New York.

Soil Survey Staff (2010). Keys to soil taxonomy (eleventh edition). United Department of Agriculture (USDA) and natural resources conservation service (NRCS)

Uddivira, M. N. W. and Camps, G. (2006). Effects of organic matter and calcium on soil structural stability. British Soc. Of soil sci. *European Jour. of soil sci.* 58: 722 – 727

Article DOI: 10.52589/AJENSR-XHAYSJCR

DOI URL: https://doi.org/10.52589/AJENSR-XHAYSJCR