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Effect of Seedbed Methods on Aggregate Stabilty of Soils and Physiological Maturity of Yams Under Organic Based Manure in Oruk Anam, Nigeria.

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Abstract

The effect of seedbed method on aggregate stability of soils and physiological maturity of yams under organic based manure was carried out on 2025 at the Teaching and Research Farm of Akwa Ibom State University, Nigeria to identify soil management. The experiment was a 3 x 3 x 2 factorial experiment, involving seed bed methods (ridge, mount and flat) as the main treatment, organic manure (poultry manure, piggery droppings and cow dung manure) as the sub treatment and yam varieties (Discorea rotundata and Discorea alata) were the sub-sub treatments. Soil samples were taken randomly from the experimental field at 0-20 cm depth, bulked for physico-chemical analysis of the soil. Five plants were randomly selected from the inner rows of each plot and tagged for easy Identification for data collection. Data were collected on growth and yield parameters. Data obtained from the soil properties, growth and yield parameters were subjected to statistical analysis. The results obtained revealed that the soil was dominated by sand fraction (82.15 %), with low silt (9.50 %) and clay (8.35 %) contents, classifying it as a sandy loam. Control had the highest aggregate stability indices of MWDD (11.67^a), MWDW (16.18^a), GMDD (0.17^a), GMDW (0.94^a), DR (0.54^a) and PSDI (75.03^a). Aggregate stability decreased with increase in seedbed methods. Soil pH (in water) was 5.7. Organic carbon (0.85%) and total nitrogen (0.07%) were low. Available phosphorus (9.40 mg kg^{-1}) was moderate. Exchangeable calcium (2.81 cmol kg^{-1}), magnesium (1.22 cmol kg^{-1}), and potassium (0.19 cmol kg^{-1}) were moderate. Bulk density (1.48 Mgm^{-1}) was slightly high, indicated minor compaction, while porosity (43.5 %) was moderate. The results of Variety × seedbed interaction for number of leaves revealed that D. alata on ridge developed leaves that supported a larger photosynthate pool for tuber bulking. D. rotundata had substantially fewer leaves under control and flat treatments, and had lower yields. Ridge × D. alata yields the best canopy and tuber bulking. The results shows that seedbed methods had a strong influence on vegetative growth and yield ($p < 0.001$). Ridge and mound seedbed methods improved yam tuber bulking than flat or control treatments, also produced larger canopies and more leaves, while flat and control produced smaller canopies. Application of animal manures increase organic carbon and nutrient supply. Minimize post plant tillage prevent aggregate break down.

Keywords: Seedbed methods, aggregate stability, organic based manure, yam physiological maturity.

Introduction: Physical, chemical, biological manipulation of soil operation for planting is important for significant performance of crop yield. Appropriate tillage practices are those that avoid degradation of soil properties, but maintain crop yield as well as ecosystem stability. Poor soil management practices (seedbed) lead to soil instability and low inherent fertility in most soils is responsible for poor crop yield (Essien, *et al*., 2023a). Tillage is a technique of mechanical manipulation of soil to provide a good environment for seed germination and plant growth (Zang *et al*., 2012). Essien *et al.* (2021) explained that tillage is the major practices that influences the physical, chemical and biological properties of soil and subsequently affects nitrogen fixation. Conventional tillage is a practice that improves soils tilt, soil drainage, soil aeration, root development and accelerates organic matter decomposition by soil micro-organism (Moussa-Machraou *et al*., 2010). It also enhances early and fast development of plant and in turn causes erosion and nutrient loses from the soil through leaching (Essien *et al.*, 2019; Mark *et al*., 2024).

Aggregate instability is one of the major problems that affect soil degradation and development. Ability of soil to attain proper aggregation (Essien and Ogban, 2018), and its arrangement of solid and voids influences water retention and nutrient uptake by plant. According to Tisdall and oades (1982), aggregation is the result of complex interaction among physical, chemical and biological processes in the soil. Soil aggregates are important for crop establishment, infiltration rather than runoff and compaction (Elliot, 1986) and are indicators of soil structural condition as well as erodibility (Haunes and Bears, 1996; Ogban and Essien, 2016). Kay (1998) reported on factors influencing aggregates stability, which are the environmental factors soil management factor, plant influence and soil properties. Chen and Juma (1998) viewed soil temperature and moisture as two of the factors affecting aggregation. Amezketa (1999) classified the factors into soil primary characteristics or internal factors (e.g. electrolyte, clay mineralogy and organic matter). Consequently, high rainfall also encourages detachment in soil particles, thereby predisposing the soils to severe erosion and soil loss (Ogban *et al.,* 2022; Essien *et al.,* 2023b). Organic manure is a vital element of soil quality and fertility, it contribute to soil nutrient and ecosystem stability. The determinants of soil organic matter distribution is importance in agriculture and environmental sustainability (Akpan *et al*., 2021). Organic materials help in maintaining soil physical fertility, is the component that contribute to the soil physical properties and processes to the ability of the soil to perform its functions and support ecosystem services (Ogban, 2021).

Okwor *et al.* (1998) stated that yam (Dioscorea Spp) are climbing perennial monocotydons donous tuber crops, and sometimes aerial starchy tubers that grown as a staple food, under family Dioscoraceae and the genus include more than 600 different species worldwide. The crop is grown in over 47 countries but Nigeria leads the pack with more than 50% of the production (38 million tonnes). The predominant yam grown in the world is the white guinea yam (Discorea rotundata). Dioscorea tubers have nutritional advantages over other root crops. It is a good source of essential dietary supplement such as protein, well balanced essential amino acids and many dietary minerals. Yam tuber crops occupy a remarkable position towards food security of the developing world due to their high calorific value and superior carbohydrate content (Mignouna and Dansi, 2003). Ikeorgu (2003) explained that yam play important role in food and nutritional security and have potential to contribute to sustainable food system under climate change. Discorea spp provides food and medicines to millions of people in the world especially in the tropics and sub tropics. It is recognized as the fourth most important tuber crop after Potatoes, Cassava and Sweets Potatoes (Akata *et al.*, 2024). It contributes about 10% of the total root and tubers production round the world. Yams is also considered as famine food and plays a prime role in the food habit of small and marginal rural families and Forest dwelling communities during the food scarcity periods (Akata *et al*., 2025a).

Muzac-Tucker *et al.* (1993) pointed out that freshly harvested yam tuber contains 70% water, 25% starch, 1 – 2 % protein and traces of sugar and vitamins. There are numerous species of yam: - Dioscorea rotundata (white yam), D. Cayenensis (yellow yam), D. alata (water yam), D. esculenta (Chinese yam), D. bulbifera (Aerial yam), Dioscorea dometoru (Martin *et al*.,1984). The use of organic fertilizer boost crop performance and increases productivity. Manure (Poultry manure, cow dung manure and piggery manure) contain nearly all the nutrients needed for crop development, as well as improve soil stability. Poor management practices lead to soil instability and low fertility in most soils, also production of yam has been on the decrease due to wrong methods of land preparation (Ogban and Essien, 2016). It has become extremely important to diversity in the present – day agricultural system as well as to search for alternative seed bed methods that will guide against instability and proper development and maturity of yam. Therefor the study seek to evaluate effect of seed bed methods on aggregate stability and physiological maturity of yams on soils with application of various organic manure. Poor soil management practices that lead to soil instability and low inherent fertility in most soils is responsible for poor crop yield (Essien *et al.,* 2024). Essien *et al. (*2019) explained that tillage is mechanical manipulating of soil to provide a good environment for seed germination and growth of plant, furthermore the author pointed out that tillage is the major practices that influences physical, biological and chemical properties of the soil and subsequently affects nitrogen fixation (Zang *et al.,* 2012).

Yam play major role in food and nutritional insecurity, it has become extremely important to diversity in the present – day agricultural system as well as to search for alternative seed bed methods that will guide against instability as well as proper development and maturity of Yam. Some wild root and tuber crops occupy a remarkable position towards food security of the developing world due to their high calorific value and superior carbohydrate content. Despite the economic value production of yam, its production has been on the decrease, mainly due to poor soil fertility and land preparation. The study described the ethnobotany of yam species in relation to their nutritional, anti – nutritional and pharmacological properties and highlights the potentiality for food and nutritional security for combating the hidden hunger that caused micro – nutrient deficiencies, moreover the study evaluated effect of seed bed methods on aggregate stability, compare growth and yield performances of various yam plants grow on soils with application of various organic manure.

Materials and Methods: Experimental Site and Cropping History : The study was carried out during the 2025 cropping seasons at Akwa Ibom State University, Obio Akpa Campus. Obio Akpa located at (Latitude 5’ 17 and 5°27N Longitude 7'27 and 7'58'E and an altitude of 38.I m above sea level. This rainforest zone receives about 2500 mm rainfall annually. The rainfall pattern is bimodal, with long (March – July) and short (September – November) rainy seasons separated by a short dry spell of Uncertain length, usually during the month of August. The mean relative humility is 78%, atmospheric temperature is 30^0C and the mean sunshine hours is 12 (Petters *et al.,* 1989). Relative humidity ranges from 75 to 85%. The natural rainforest vegetation has lost its original nature due to anthropogenic activities arising from population increase. The soils are better drained, crops grown are mainly cocoyam (Ibanga *et al.,* 2023) carrot (Akata *et al.,* 2021), pepper (Akpan *et al.,* 2023), cassava (Akata *et al.,* 2024; Edet *et al.,* 2025), okro (Akpan *et al.,* 2024; Ekwere *et al.,* 2022), pumpkin (Akata *et al.,* 2025a), groundnut (Akata *et al.,* 2025b), garlic (Akpan *et al.,* 2025). Poor management and improper land use cause soil degradation and low productivity (Etukudoh, 1990; Simeon and Essien, 2023).

Land Preparation, Treatment and Experimental Design? : The experimental site was cleared and treatment plots were marked out. The main treatment plots were measured 10 x 10 m and sub treatment plots were 10 x 10 m, giving a total of 10,000 m. Area measured out for seedbed methods were ridge and mound were appropriate. The experiment was laid out in a Randomized Complete Block Design with three treatments, involving seed bed methods (ridge, mount and flat) as the main treatment, organic manure (poultry manure, piggery droppings and cow dung manure) as the sub treatment and yam varieties (Discorea rotundata and Discorea alata) were the sub-sub treatment.

Husbandry Practices :**Yam (Dioscorea spp) plants was planted in the marked plots at a spacing of 1m × 1m. The different organic based manure was applied after full establishment of the yam plants. Harvesting of the yam was done when plants has attained maturity with spade. Stalking was done with the used of bamboo stick in line with the cultural practices adopted for yam production.**

Data Collection /Analysis :**Soil samples were collected at four points in the experimental plot at the depth of 0 – 20 cm, bulked to form composite sample. The bulked sample was air – dried and sieved through a 2 mm sieve, used for the following physico–chemical analyzes; particle size distribution was done with a dispersing agent using the Bouyoucos hydrometer method (Gee and Bauder, 1986). Soil pH was determined in water using a 1:2.5 soil to water ratio suspension and the pH value read with a glass electrode pH meter (Udo *et al.*, 2009). Total nitrogen was obtained by the macro Kjeldah digestion method as described by Jackson (1962). Available phosphorus was determined by using the Bray – p1 method as described by Udo *et al.*, (2009). Exchangeable bases Ca, Mg, Na and K were extracted with I N NH_4 OAC solution. Na and K were measured with flame analyzer, while Mg and Ca were determined by Ethylenediamine tetra – acetic acid (EDTA) titration method. Exchangeable acidity was extracted with I M KCI solution and the acidity in the extracts was measured by titration with 0.01 M NaOH as described by Udo *et al.*, (2009).**

Aggregate Size Distribution Analysis: Aggregate separation was determined by physical separation through wet and dry sieving methods. Aggregate size were separated into a nest of four sieve sizes (4.0 – 2.0, 2.0 – 0.25, 0.25 – 0.05, < 0.05 mm), which represent the large macro aggregate, small macro aggregate, micro aggregate and mineral fraction. Wet aggregate fractions were oven dried and sand fractions performed on each aggregate size fraction with the used of Calgon, oven dried and sieved through 0.25 mm sieve.

Plant Data Collection : Five plants were randomly selected from the inner rows of each plot and tagged for easy Identification. Data were collected on growth and yield parameters:

Establishment percentage: This was determined at one month after planting by counting the number of spouted yams stands.

Vine Length (cm) : **It was determined by measuring the length of the main vine from the ground level to apex of growing point using a meter rule**

Number of leaves per plant: **This was determined by counting the number of leaves of ten plants in inner row and taking the mean to the nearest whole number.**

Leaf Area (cm^2) :**Leaf area was determined by measuring the length and weight of leaf and multiplied by the corrected factor (0.705) (Karimi *et al.*, 2009; Akpan *et al.*, 2023).**

Number of tubers per plant : Number of tubers per plant was determined by physical counting of seed tubers per plant.

Length of tubers (cm) **Length of tubers were determined by measuring the length of tuber head to the tail of ten tubers per plot with measuring tape and the mean calculated to the nearest length tuber.**

Tuber circumference: **Tuber circumference was determined by measuring the circumference of ten tubers per plot at the middle portion with Veneer calipers.**

Tuber yield (t/ha) : Tuber weight was determined with the aid of top load weighing balance the weights were later converted to tones per hectare

Statistical Analysis: Data obtained from soil sample and growth and yield parameters was subjected to analysis of variance. Means that showed significant differences were compared using the Least Significant Differences at 5 % probability level. Statistics package include, CV, ANOVA, F values and p values, LSD (0.05), DMRT groupings,

Results And Discussion: Physico - chemical Properties of Soils in the Study Area: The physical and chemical characteristics of the experimental soil before planting are presented in Table1. The result showed that in the study area, the soil was dominated by sand fraction (82.15 %), with low silt (9.50 %) and clay (8.35 %) contents, classifying it as a sandy loam. This texture promotes yam rooting but reduces nutrient and moisture retention. Such soils are common ultisols in Akwa Ibom State, characterized by low fertility. Soil pH (in water) was 5.7, indicating moderate acidity favorable for yam cultivation. Organic carbon (0.85%) and total nitrogen (0.07%) were low, suggesting poor fertility and the need for organic matter inputs. Available phosphorus (9.40 mg kg^{-1}) was moderate. Exchangeable calcium (2.81 cmol kg^{-1}), magnesium (1.22 cmol kg^{-1}), and potassium (0.19 cmol kg^{-1}) were moderate. Bulk density (1.48 Mgm^{-1}) was slightly high, indicating minor compaction, while porosity (43.5 %) was moderate.

Effect of Seedbed Methods for Growth and Yield of Yam : The results in Table 2a , 2b and 3 showed that analysis of variance, indicated that seedbed methods had a strong influence on vegetative growth and yield ($p < 0.001$). Ridging and mounding improved yam production by supporting better root exploration and tuber bulking than flat or control treatments. Ridge and mount seedbeds method produced larger canopies and more leaves. Flat and control seedbeds restricted root penetration and produced smaller canopies. The result in Table 3 revealed that seedbed, such as ridge (25.25) and mount (23.49) recorded high values, which enhance and improved vegetative growth and yield, while flat (18.57) and control (10.79) recorded low yield.

Effect of Seedbed Methods on Soil Aggregate Stability :**The results in Table 4 shows that control had the highest aggregate stability indices of MWDD (11.67[a]), MWDW (16.18[a]), GMDD (0.17[a]), GMDW (0.94[a]), DR (0.54[a]) and PSDI (75.03[a]). Aggregate stability decreased with increasing soil disturbance. Control plots retained the most stable aggregates. Ridge and mount treatments reduced aggregate stability, because of mechanical disturbance. While ridging enhances root penetration and yield, organic matter additions and reduced post plant tillage are necessary to mitigate long term structural decline.**

Effects of Variety, Seedbed, and Manure on Growth and Tuber Yield : **Effects of variety, seedbed, and manure on growth and tuber yield Table 5a, with emphasis on the significant variety by seedbed interaction for yield and number of leaves, effect sizes. Pig droppings improved a balanced supply of nutrients in the sandy soil, supporting tuber bulking. Cattle dung and poultry manure also improved yields significantly over control. Varietal differences had agronomical impact on, while variety main effect on yield was not significant.**

Effect of Variety on Growth and Yield Parameter: The results in Table 5b shows that variety effects on leaf area was not significant, and there was varieties different in tuber morphology and in response to seedbed. *D. alata* mean yield 22.4 ± 3.5 t ha^{-1} versus 20.1 ± 3.2 t ha^{-1} for *D. rotundata*, absolutely difference 2.3 t ha^{-1} or about 11.6 % higher for *D. alata*, not statistically significant because difference < LSD (3.448). *D. rotundata* produced longer tubers (34.8 ± 2.5 cm) than *D. alata* (26.4 ± 1.8 cm). 32.0 % longer. *D. alata* had larger circumference (28.9 ± 2.1 cm) than *D. rotundata* (23.1 ± 1.9 cm), 25.1 % greater. The results of uber per plant, also shows that *D. alata* (1.16 ± 0.14), was higher than *D. rotundata* (1.11 ± 0.12) with 4.5 %.

Variety × Seedbed Interaction for Yield : The results (Table 6) of Variety × Seedbed Interaction for Yield (t ha^{-1}); LSD = 3.448, presented in Table 6 shows that *D. alata* on ridge produced the highest yield and is statistically distinct at $p \leq 0.05$. Mount seedbeds supported comparable yields for both varieties. Flat and control plots gave low yields for both varieties. Practically, *D. alata* on ridge yielded about 34.4 % more than *D. rotundata* on ridge.

Effect of Organic Manure on Growth and Yield of Yam: The results in Table 8 shows that all organic manures increased yield compared with the control, pig droppings gave the highest yield, followed by cattle dung and poultry manure.

Interaction of Variety and Seedbed Methods : **The results of Variety × seedbed interaction for number of leaves revealed that *D. alata* on ridge developed larger leaves, supporting a larger photosynthate pool for tuber bulking. *D. rotundata* had substantially fewer leaves under control and flat treatments, consistent with lower yields. Ridge × *D. alata* yields the best canopy and tuber bulking.**

Discussion: **Analysis of variance showed that seedbed type had a highly significant effect on leaf area ($F = 12.45; p < 0.001$), number of leaves ($F = 18.67; p < 0.001$), and yield ($F = 22.34; p < 0.001$). Variety main effect on yield was not significant. However, variety by seedbed interaction was significant for both number of leaves and yield ($p < 0.01$). Post hoc mean separation using Duncan's Multiple Range Test ($\alpha = 0.05$) indicated that *Dioscorea alata* planted on ridge beds produced the highest canopy development (21.4 leaves per plant) and the highest mean tuber yield (28.95 t ha^{-1}), and it was statistically distinct from most other variety by seedbed combinations. Across all treatments, *D. alata* produced slightly greater mean tuber yield than *D. rotundata* (22.4 versus 20.1 t ha^{-1}), a practical increase of about 11.6 percent, but this overall difference did not reach statistical significance under the experimental error observed (LSD for yield = 3.448). Tuber form differed by variety: *D. rotundata* produced longer tubers (mean length 34.8 cm) whereas *D. alata* produced thicker tubers (mean circumference 28.9 cm). These morphological differences explain the yield patterns and suggest variety specific recommendations for farmers: adopt ridge planting to maximize yield in *D. alata*, while ensuring adequate organic matter to sustain structure and fertility for both varieties (Agbede, 2013). Regular additions of organic material are recommended to sustain soil quality.**

Conclusions and Recommendation: The soil was sandy in nature and low in nutrient contnet. Such soils lose nutrients easily through leaching, lose organic matter rapidly, and exhibit weak aggregation. These characteristics justify the experimental use of organic manures and modified seedbed methods to improve soil structure, increase moisture holding capacity, and supply nutrients. Similar observations for coarse textured soils in southern Nigeria have been reported by Agbede (2010); Ogban and Essien, 2016. Variety by seedbed interaction is the key finding: ridging benefits *D. alata* most and also benefits *D. rotundata*, though to a lesser extent. Pig droppings were the most effective manure across varieties. Promote *D. alata* for farmers aiming for higher yield under improved seedbeds, while seedbed advice should be variety specific. Ridge produced the greatest yield advantage and is recommended where labour and soil conditions permit. The following recommendations are suggested for extension and training programmes: Ridge or mount seedbeds methods should be adopted for higher yield**s.** Adoption of animal manures are suitable for improvement of soil nutrient. Prioritizing pig droppings or cattle dung, increase organic carbon and nutrient supply Minimize post plant tillage to protect aggregates and use surface mulch to conserve moisture.

References

Amezketa, E. (1999). Soil Aggregate Stability: A review. *Journal of Sustainable Agriculture*, 14, 83–151.

Agbede, T. M. (2010). Tillage and Fertilizer Effects on Some Soil Properties, Leaf Nutrient Concentrations, Growth and Sweet Potato Yield on An Alfisol In Southwestern Nigeria. *Soil and Tillage Research*, 110 (1), 25–32.

Agbede, T. M. (2013). Effects of Organic Fertilizers on Yam Productivity and Some Soil Properties of a Nutrient Depleted Tropical Alfisol. *Archives of Agronomy and Soil Science*, 60(4), 511–526.

Akata, O. R., Essien, O. A., Ben, F. E., & Ikeh, A. O. (2025a). Performance of Fluted Pumpkin (telfairia occidentalis hook f.) Under Different Nitrogen Fertilizer Grades in a High Humid Ecology of Southern Nigeria. *Akwa Ibom State University Journal of Agricultural and Food Sciences,* 9(2), 82– 93.

Akata, O. A., Essien, O. A., Akpan, E. A., & Ben, F. E. (2025b). Evaluation of land preparation of Bambara groundnut in an Ultisol. *Nigerian Journal of Horticultural Science,* 29(1), 55–60.

Akata, O. R., Essien, O. A., Akpan, E. A., & Akpan, E. G. (2024). Effect of Inorganic Fertilizer and Lime Rate on Chemical Properties of Soil and Yield of Cassava (Manihot esculenta Crantz) in Obio Akpa, Akwa Ibom State. *Journal of Agriculture, Environmental Resources Management,* 6(5), 48–60.

Akata, O. R. and Ikeh, A. O. (2021) Response of Groundnut (Arachis hypogaea L.) Varieties to Intra-row Spacing in Rainforest Zone of Southeastern Nigeria. *Nigeria Journal of Agriculture, Food and Environment*, 17 (2); 57 – 64.

Akpan, E. E., Elijah, A. A., Essien, O. A. (2021). Response of Carriot (*Daucus carota L.*) to Different Organic Fertilizer in Obio Akpa, Akwa Ibom State. *Nigerian Journal of Agricultural Technology,* 18; 46 – 52.

Akpan, E. A. Akpan, A. S and Essien, O. A. (2023). Effect of Decapitation on the Growth and yield of Pepper (Capsicum annum L.) in Obio Akpa, Akwa Ibom State. *Journal of Agriculture and Food science Akwa Ibom State University.* 7(1): 9 – 21.

Akpan, E. A., Essien, O. A., Akata, O. R., & Opeolv, E. M. (2024). Effect of Oil Palm Bunch Ash and Harvesting Intervals on Okra (Abelmoschus esculentus L.) Cultivars in Obio Akpa, Akwa Ibom State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 20(1), 21–30.

Akpan, E. A., Bernard, A. E., Essien, O. A., Akata, O. R., and Ben, F. E. (2025). Effect of Organic Fertilizers on Growth and Yield of Garlic (Allium sativum L.) in Obio Akpa, Akwa Ibom State. *Asian Research Journal of Agriculture*, 18 (1); 61 – 69.

Chen, Z. S. Pawluk, and N. G. Juma (1998). Impact of Variation in Granular Structures on Carbon SeMuestration in two Alberta Mollisols. P. 225 – 243. In R. Lal *et al.* (edition) Soil Processes and the Carbon Cycle. *Advance Soil Science CRC* Press. Boca Ration FI.

Essien, O. A., Udoh, O. E., Umoh, F. O. and Ntuen, E. S. (2021). Evaluation of Tillage Methods and Potassium Effect on Soil Properties and Growth of Lesser yam. *International Journal of Agricultural Research and Food production.* 6(2): 19 – 29.

Essien, O. A., Ogban, P. I., Arthur, G. J., Sam, I. J. and Edet, I. G. (2024). Effect of Slope Gradient on Soil Properties and Organic Matter Quality in Aggregate Size Fraction on Coastal Plain Sand Soils Southeastern Nigeria. *Asian Journal of Soil Science and Plant Nutrition,* 10 (4), 480 – 492.

Essien, O.A., Udoh, O.E. and Ijah, C.T. (2023a). Investigation of Roles of Seedbed Methods and Mulch Types On Soil Properties In Acid Soils, Southeastern Nigeria. *Journal of Agriculture, Environmental Resources and Management*, 5(5): 994-1006.

Essien, O.A., Akpan, E.A. and Akata, O.R. (2023b). Comparative Methods of Land Use Practices Effect on Clay Dispersion in Coastal Plain Sand in Southeastern Nigeria. *Journal of Agriculture, Environmental Resources and Management*, 5(6): 1022-32.

Essien, O. A., Sam, I. J., & Umoh, F. O. (2019). Effect of Raindrop Impact and Its Relationship with Aggregate Stability on Sandstone/Shale Parent Material in Akwa Ibom State, Nigeria. *Nigerian Journal of Agricultural Technology, 16,* 6–73.

Essien, E. A., and Ogban, P. I. (2018). Soil Erosion and Sedimentation in Akwa Ibom State, Nigeria. *Journal of Environmental Sciences and Health, Part C*, 36, 1-13.

Elliot, E. T. (1986). Aggregate Structure and Carbon, Nitrogen and Phosphorus in Native and Cultivated Soils. *Soil Science Society of America Journal*, 50, 627–633.

Ekwere, O. J., Umoh, F. O., & Essien, O. A. (2022). Effect of Poultry Manure and Lime on The Growth And Yield Of Okra. *Nigeria Journal of Crop Science,* 8(1), 15–22.

Edet, C. E., Ibia, T. O., Essien, O. A., Akata, O. R., & Afangide, A. I. (2025). Influence of Tillage Particles and Nutrient Application Rates on Performance of Cassava in Coastal Plain Sand, Etinan, Akwa Ibom State. *Journal of Agriculture, Forestry and Environment,* 9(1), 129–145.

Gee, G W and Bauder, J. W. (1986). Particle Size Analysis. In Method of Soil Analysis. I (ed. A.Klute) *American Society of Agronomy*, Madison .W.I.9, 91-100.

Haynes, R. J. and Beare, M. H. (1996). Aggregation and Organic Matter Storage in Meso – Thermal Humid Soils. In: M. R: Carter and B. A. Stuart (edition). *Structure and Organic Matter Storage in Agricultural Soils. CRC Press,* New York.

Ibanga, F. I., Essien, O. A., Imoh, F. O., James, A. F., & Emmanuel. (2023). Evaluation of Growth and Yield of Cocoyam on Varying Rates of Organic Manure in Cocoyam-Based Intercropping System. *American Journal of Life Science,* 11(3), 50–55.

Jackson, M. I. (1962). Soil Chemical Analysis. 1st Edition, Prentice Hall, New Jersey, USA., page: 498.

Karimi, S. Taravali, V. Rahemi, M. Rostaumi, A. A. and Veazpour, M. (2009): Estimation of leaf Growth on the Basis of Measurements of Leaf Length and Widths, Choosing Pistachio Seedlings as Model. *Australian Journal of Basis and Applied Science*, 3(2): 1070 – 1075.

Kay, B. D. (1998). Soil Structure and Organic Carbon: a Review in lal, r. Kimble, J. M. Folliet, r. F., Stewart, b. A. (eds). Soil Processes and the Carbon Cycle. *CRC Press Boca Ration, F. L.* PP. 167 – 169.

Petters, S. W. Usoro, E. J., Obot, U. W. and Okpon, S. N. (1989). *Physical Background Soils and Landuse and Ecological Problems.* Technical Report of the Task Force on Soils and Landscape Survey Akwa Ibom State Government Print Office, Uyo. 603.

Landon, J. R. (1991). *Booker Tropical Soil Manual: A Handbook for Soil Survey and Agricultural Land Evaluation in the Tropics and Subtropics*. Longman, London.

Mark, I. F., Udoh, B. T. and Essien, O. A. (2024). A Comparative Soil Characteristics under Different Agricultural Land Use Systems in a Coastal Plain Sand Soils of Akwa Ibom State, Nigeria. *Nigerian Journal of Agricultural Technology.* 20; 1 – 9.

Mignouna, H. O., Dansi, A. (2003). Yam (Dioscorea spp.). Domestication by the Nago and Fon Ethnic Groups in Benin. Genet Resource Crop Evol. 50: 519 – 528.

Moussa – Machraoui, S. B., Errouissi, F., Ben, H. M., and Uduria, S. (2010). Comparative Effects of Conventional and no tillage management on some soil properties under Mediterranean Semi – arid conditions in north western Tunisia. Soil Till and Resources. 106, 247 – 253.

Muzac – Tucker, I., Asemota, H. N. and Ahmad, M. H. (1993). Biochemical Composition and Storage of Jamacian Yams (Dioscorea spp.). *Journal of Science of Food and Agriculture*, 62 (2); 19 – 24.

Ogban, P. I. (2021). Influence of Slope Aspect and Position on Soil Physical Quality and Management Implications at University of Uyo Teaching and Research Farm, Akwa Ibom State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension*, 20 (3); 37 – 48.

Ogban, P. I., Ibotto, M. I., Utin, U. E., Essien, O. A., & Arthur, G. J. (2022). Effect of Slope Curvature and Gradient on Soil Properties Affecting Erodibility of Coastal Plain Sands in Akwa Ibom State, Nigeria. *Agro- Science*, 21(2), 12–23.

Ogban, P. I., & Essien, O. A. (2016). Water- Dispersible Clay and Erodibility in Soils Formed on Different Parent Material in Southern Nigeria. *Nigerian Journal of Soil and Environmental Research*, 14, 26–40.

Okwor, G. C., Asiedu, R. and Ekanayake, I. J. (1998). Food Yam, Advanced in Research. IITA and NRCRI.

Simeon, S. D., & Essien, O. A. (2023). Evaluation of Some Soil Physico-Chemical Properties and Implication on Soil Fertility in Etinan, Akwa Ibom State, Nigeria. *Akwa State University Journal of Agriculture and Food Science,* 7(3), 86–93.

Tisdall, J. M. and Oades, J. M. (1982). Organic Matter and Water Stable Aggregates in Soils, *Journal of Soil Science*., 33, 141 – 163.

Udo, E. J., Ibia, T. O., Ogunwale, J. A., Ano, A. O., & Esu, I. E. (2009). *Manual of Soil, Plant and Water Analysis*. Sibon Books, Lagos.

Zhang, B., Ding, It., Zhang, X. and Filley, X. (2012). Soil Microbial Community Dynmaics over a Maize (Zea mays L.) Carowing Season Under Convertional and No-tillage Practices in a Rainfall Agroecosystem. Soil Tillage and Research. 124, 153 – 160.

Table1: Selected Physical and Chemical Properties of the Soil Before Planting

Parameter	**Value**	**Unit**	**Rating or remark**
Sand	821.5	%	High, coarse textured
Silt	950	%	Low, poor water retention
Clay	835	%	Low, weak aggregation
pH (H_2O)	5.7	—	Moderately acidic, favorable for yam
Organic carbon	0.85	%	Low, poor fertility
Total nitrogen	0.07	%	Low
Available phosphorus	9.40	mg kg^{-1}	Moderate

Calcium	2.81	cmol kg⁻¹	Adequate
Magnesium	1.22	cmol kg⁻¹	Moderate
Potassium	0.19	cmol kg⁻¹	Moderate
Bulk density	1.48		Slight compaction
Porosity	43.5	%	Moderate

Ratings adapted from Landon (1991).

Table 2a: Summary ANOVA for Seedbed Method Effects on Growth Parameters

Parameter	F value	p value	LSD (0.05)	CV %	Significance
Leaf area	12.45	< 0.001	2.829	8.3	Significant
Number of leaves	18.67	< 0.001	17.805	10.2	Significant
Yield (t ha⁻¹)	22.34	< 0.001	3.448	12.5	Significant

Table 2b: Effect of Seedbed Type on Leaf Area and Number of Leaves

Seedbed	Leaf area (cm²)	Number of leaves	Group (Leaf area)	Group
Ridge	47.84	203.00	A	A
Mount	47.01	157.25	A	B
Flat	41.57	130.64	B	C
Control	36.99	109.62	C	D

Means followed by the same letter are not significantly different at p ≤ 0.05 (DMRT). LSD values: leaf area = 2.829; number of leaves = 17.805.

Table 3: Mean Separation of Tuber Yield on Seedbed

Seedbed	Yield ($t\ ha^{-1}$)	Group
Ridge	25.25	a
Mount	23.49	a
Flat	18.57	B
Control	10.79	C

LSD (0.05) = 3.448

Table 4: Effect of Seedbed Methods on Soil Aggregate Stability

Seedbed	MWDD	MWDW	GMDD	GMDW	DR	PSDI %
Control	11.67^a	16.18^a	0.17^a	0.94^a	0.54^a	75.03^a
Flat	8.20^b	7.48^b	0.16^b	0.78^b	0.43^b	66.00^b
Mount	6.73^c	4.57^c	0.14^c	0.69^c	0.35^c	55.57^c
Ridge	4.60^d	6.00^d	0.13^d	0.56^d	0.23^d	42.17^d

MWDD = mean weight diameter dry; MWDW = mean weight diameter wet; GMDD and GMDW = geometric mean diameters dry and wet; DR = dispersion ratio; PSDI = percent stable dry index. Means followed by the same superscript in a column are not significantly different at $p \leq 0.05$

Parameter	Source	F value	p value	LSD (0.05)	CV (%)

Leaf area	Seedbed	12.45	< 0.001	2.829	8.3
	Variety	—	NS	—	—
Number of leaves	Seedbed	18.67	< 0.001	17.805	10.2
	Variety × Seedbed	—	< 0.01	—	—
Yield (t ha^{-1})	Seedbed	22.34	< 0.001	3.448	12.5
	Variety × Seedbd	—	< 0.01	—	—

Notes: "—" indicates not applicable; NS = not significant at α = 0.05. LSD values used for mean separations in subsequent tables.

Table 5a: ANOVA Summary for Growth and Yield Parameters

Table 5b: Mean Tuber Characteristics by Variety (n = 10 combinations per variety)

Parameter	D. rotundata (mean ± SD)	D. alata (mean ± SD)
Number tubers per plant	1.11 ± 0.12	1.16 ± 0.14
Tuber length (cm)	34.8 ± 2.5	26.4 ± 1.8
Tuber circumference (cm)	23.1 ± 1.9	28.9 ± 2.1
Tuber yield (t ha^{-1})	20.1 ± 3.2	22.4 ± 3.5

Table 6: Variety × Seedbed Interaction for Yield (t ha^{-1}); LSD = 3.448

Variety	Seedbed	Yield (t ha^{-1})	Group
D. alata	Ridge	28.95	A
D. alata	Mount	24.78	B
D. rotundata	Mount	22.20	B
D. rotundata	Ridge	21.54	B
D. alata	Flat	18.64	C
D. rotundata	Flat	18.50	C
D. alata	Control	11.18	D
D. rotundata	Control	10.40	D

Table 7: Variety × Seedbed Interaction for Number of Leaves; LSD = 17.805

Variety	Seedbed	Number of leaves	Group
D. alata	Ridge	214.4	A
D. rotundata	Ridge	191.6	B
D. alata	Mount	187.9	C
D. alata	Flat	142.6	D
D. alata	Control	127.8	E
D. rotundata	Mount	126.6	F
D. rotundata	Flat	118.7	G
D. rotundata	Control	91.5	H

Table 8: Mean Separation of Yield by Manure Type (t ha^{-1})

Manure type	Yield (t ha^{-1})	Group
Pig droppings	24.10	A
Cattle dung manure	21.64	B
Poultry manure	21.57	B
None (control)	10.79	C

LSD (0.05) = 3.448.

Table 9: Summary of Statistical Significance for Major Effects

Parameter	**Variety effect**	**Seedbed effect**	**Manure effect**	**Variety seedbed**	**× Variety manure**	**× Seedbed manure ×**
Leaf area	NS	$p < 0.001$	$p < 0.01$	NS	$p < 0.001$	$p < 0.001$
Number of leaves	NS	$p < 0.001$	$p < 0.05$	$p < 0.01$	$p < 0.05$	$p < 0.01$
Yield	NS	$p < 0.001$	$p < 0.001$	$p < 0.01$	NS	$p < 0.05$