International Journal of Research in Agriculture and Forestry
Volume 1, Issue 2, December 2014, PP 1-6
ISSN 2394-5907 (Print) & ISSN 2394-5915 (Online)

Differences in Infiltration Rate under a Catenary Landscape in Owerri, Southeastern Nigeria

Okon, M.A., G.E. Osuji

Department of Soil Science and Technology, Federal University of Technology, Owerri, Imo state Nigeria.
mikedchosen@yahoo.com

Abstract: *The study investigated the differences in infiltration rate of soils under a catenary landscape in Owerri, Southeastern Nigeria. The landscape was cut into three physiographic positions; top slope, mid slope and foot slope using transect survey technique and sampling done within the slope segments. The infiltration rate of the soils was measured using double ring infiltrometer to get the infiltration rates. Soil samples were also analyzed for selected soil properties affecting infiltration. Data obtained were subjected to correlation and regression analysis in order to estimate the relationship between infiltration rate and selected soil properties. Analysis of variance was also used to partition the variability. Graphs were plotted for infiltration rates and accumulated infiltration. Results showed that infiltration rate was very rapid in all physiographic positions. It was highest at the onset of irrigation and reduced with time to a constant or near constant value termed 'basic infiltration rate'. The basic infiltration rate values obtained were: 125cm/hr, 39cm/hr and 54cm/hr respectively for the top slope, mid slope and foot slope. There was significant difference at (P=0.05) among treatment means indicating that the basic infiltration rate varied among physiographic positions. There was negative correlation between basic infiltration rate and %clay and total porosity with values of r=-0.2366 and r=-0.5577 respectively but it positively correlated with %sand with r=O.1643. The study generally revealed significant differences in infiltration rate in the catenary landscape.*

Keywords: *Infiltration rate, Catena, Physiographic positions.*

1. INTRODUCTION

Soil-water interactions influence many of the ecological functions of soils and practices of soil management. These interactions determine how much water runs into and through the soil and how much runs off the surface (Brady and Weil, 1999). Infiltration is the movement of water into the soil from the surface by downward or gravitational flow (Osuji, 1984). The rate at which it occurs is known as the infiltration rate (Barrow, 1987) which mainly depends on the soil properties. The major factors affecting infiltration rate of water into the soil are; the initial moisture content, condition of the soil surface, hydraulic conductivity of the soil profile, texture, porosity, degree of swelling of soil colloids and organic matter, vegetative cover, duration of irrigation or rainfall and viscosity of water (Michael, 1978). Of these, soil texture is predominant (Saxton et al., 1986). '

Osuii et. al. (2010) reported that soil structure also affect the rate of water movement. Soil properties vary spatially in a catenary landscape (Okon et. al. 2014). Soil properties vary with slope positions and parent material. As the steepness of a slope increases, there is greater run-off and erosion, soil creep, less water infiltration and less water available for chemical and biological activity (Foth, 1984). The net effect is retardation in soil genesis. Erosion on steep slopes commonly results in thin soils especially where soils are underlain by bedrock. Southeastern Nigeria is characterized by pronounced soil degradation due to poor aggregation (Onweremadu et al., 2010). Thus, this study aimed at examining the differences in infiltration rate in the catenary landscape and also the degree of relationship between infiltration rates and selected soil properties in the area.

2. MATERIALS AND METHODS

The study was carried out on an eroded catena in the Otamiri river water shed in the Teaching and Research farm of Federal University of Technology, Owerri, Imo State. Owerri is located between latitude 5°25'N and 5°30'N and longitude $7^0$00'E and 7^O10'E and has a minimum and maximum temperature of 20^0C and 32°C respectively and mean annual rainfall of 2500mm (Igbozuruike, 1975).

The soils are ultisols that are rich in free iron, but have low mineral reserve (Ofomata, 1975). The site was cut into three physiographic positions; top slope, mid slope and foot slope using transect survey technique. Sampling points were located within the slope segments at 10m interval along the transect. Soil samples were collected randomly at 0-15cm and 15-30cm depth at 10m intervals at the three physiographic positions. The soil samples were air-dried and prepared for laboratory analyses. Core samples were also collected for bulk density determination. Infiltration rate was determined using the double ring cylinder infiltrometer as was described by (Landon, 1991, Brady and Weil, 1999). Bulk density was determined using the core method (Grossman and Reinsch, 2002). Particle size analysis was done by the hydrometer method according to the procedure of Gee and Or (2002). Porosity was calculated from bulk density value. Soil pH was determined using 1:2.5 soil water ratio with a pH electrode and values were read out from the pH meter (Hendershot et al., 1993). Total Nitrogen was determined using Walkley and Black oxidation method (Nelson and Sommers, 1982). Available phosphorus was determined using Bray 2 solution method according to (Olsen and Sommers, 1982). Exchangeable Ca and Mg were determined by EDTA versanate titration method as outlined by (Mclean 1982). Exchangeable Na and K were determined by flame photometer method. Exchangeable acidity was determined by leaching the soil with 1N KCL and titrating with 0.05N NaOH (Mclean, 1982). Soil data were analyzed using correlation and regression analysis in order to estimate the relationship between infiltration rates and selected soil properties. Graphs were also plotted for infiltration rate and accumulated infiltration. Analysis of variance was used to partition the total variability in some observations made among the possible sources of variability to each of the known sources of variation. Means were separated using least significant difference (LSD).

3. RESULTS AND DISCUSSION

The graph of measured infiltration rates and accumulated infiltration are shown in the figures below. The infiltration rate values can be read from the graphs. From the graphs, infiltration rate was very rapid in all physiographic positions. It was highest at the on-set of irrigation and reduced with time to a constant or near constant value termed “basic infiltration rate". This is in corroboration with Michael, (1978) who reported that infiltration rate decreases with irrigation. According to Lal, (1990), the decrease in infiltration rate with time results from reduction in moisture potential gradient, changes in size distribution of transmission pores and alterations in soil structure. The research work showed different infiltration rate values even in the same slope segment on the catenary landscape, due to an interplay of different factors. The mean basic infiltration rate values however were 124cm/hr, 39cm/hr and 54cm/hr respectively for the top slope, mid slope and foot slope. These rapid values can be attributed to the preponderance of sand in the study area. The analysis of variance which was done using the basic infiltration rate values showed significant difference at (P=0.05) among treatment means indicating that the basic infiltration rate varied among the physiographic positions. The result of other studied soil properties are shown in Table 1. The catenary landscape was found to be sand for the top slope and mid slope and sandy loam to loamy sand for the foot slope. The same table also showed that the bulk density values were not up to the critical level of 1.85 showing that the soils were not compacted. Organic matter content of the study area was generally low; it increased towards the foot slope. This can be attributed to erosion and washing of organic matter from the top slope towards the foot slope. Relationship between basic infiltration rate and other selected soil properties can be seen in Table 2. There was a negative correlation between basic infiltration rate and bulk density and %clay with values of r=-05441 and -0.2366 respectively. Basic infiltration rate correlated positively with %sand (r=0.1643). This showed that percent sand exerted little influence on the basic infiltration rate. This was in contrast with the work of Saxton et al. (1986) who stated that the influence of texture on infiltration rates predominates other factors. This study revealed that even with the same texture, other factors can interplay to cause significant differences in infiltration rates. The study also revealed that basic infiltration rate correlated negatively with porosity (r=-0.5577).

4. CONCLUSION

The research work revealed differences in infiltration rate in the catenary landscape. This is due to the effect of the intrinsic properties of the soils of the different physiographic positions. Organic matter increased down slope due to materials deposited on the foot slope from the top slope. Infiltration rate was rapid in all physiographic positions. There were varying inter relationships between basic infiltration rate and other studied properties of the soil. Finally, based on the results of this study, it is recommended that planting of row crops should be avoided on this eroded catenary landscape as this gives rise to more serious erosion problems or row crops can be combined with protection effective crops in a logical cropping pattern. Cover cropping, strip cropping and mulching are good conservation practices. Furthermore, overhead methods of irrigations should be done on this landscape rather than surface irrigation. This is due to the poor uniformity of application, deep percolation losses, excessive leaching of soil nutrients and low irrigation efficiency obtainable in surface irrigation.

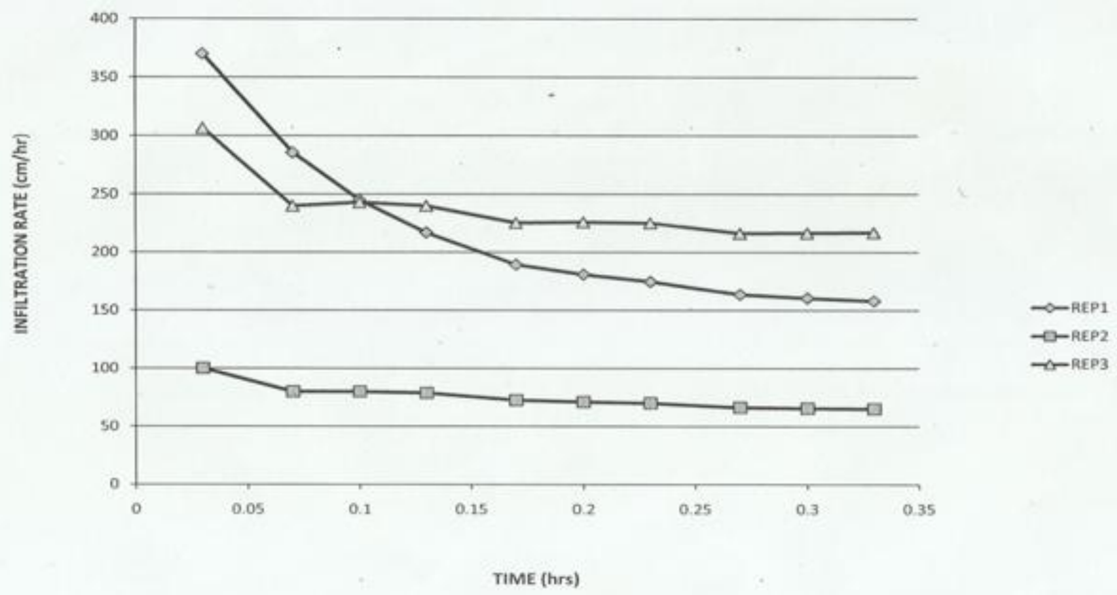

Fig. Graph Of Infiltration Rate For The Top Slope

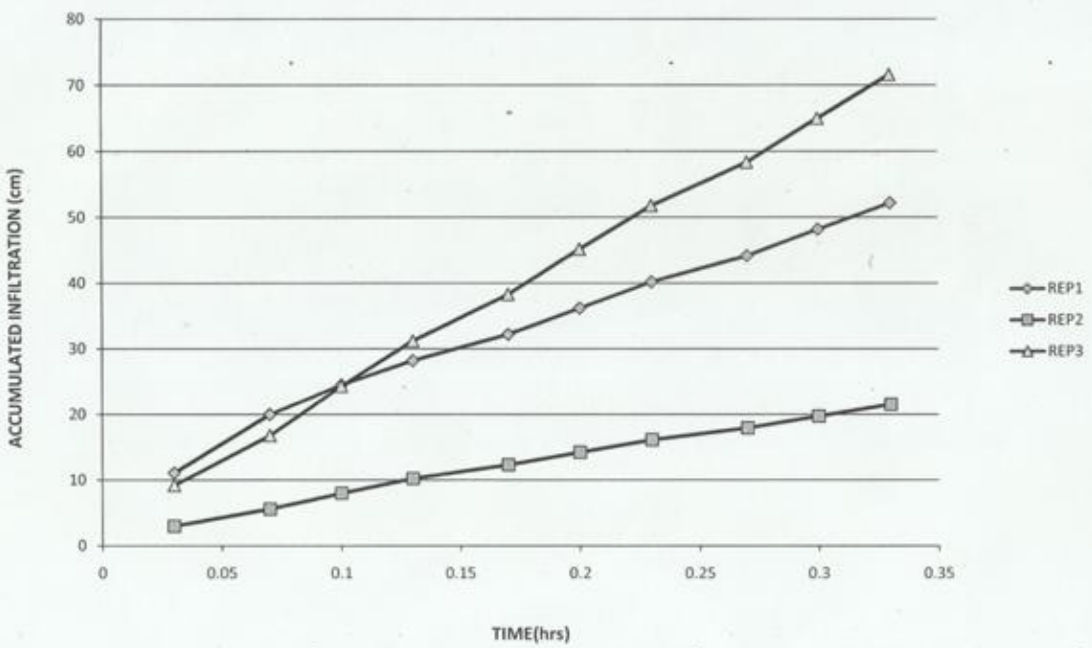

Fig. Graph of Accumulated Infiltration For The Top Slope

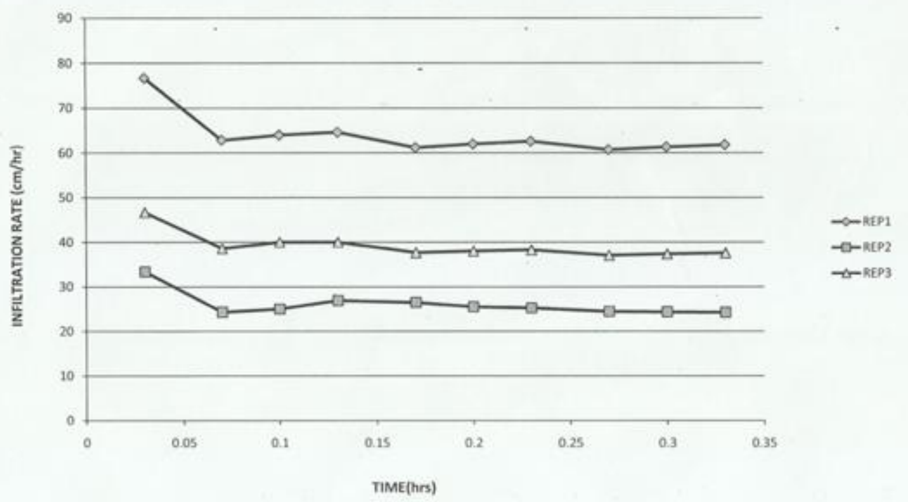

Fig. Graph Of Infiltration Rate For The Mid Slope

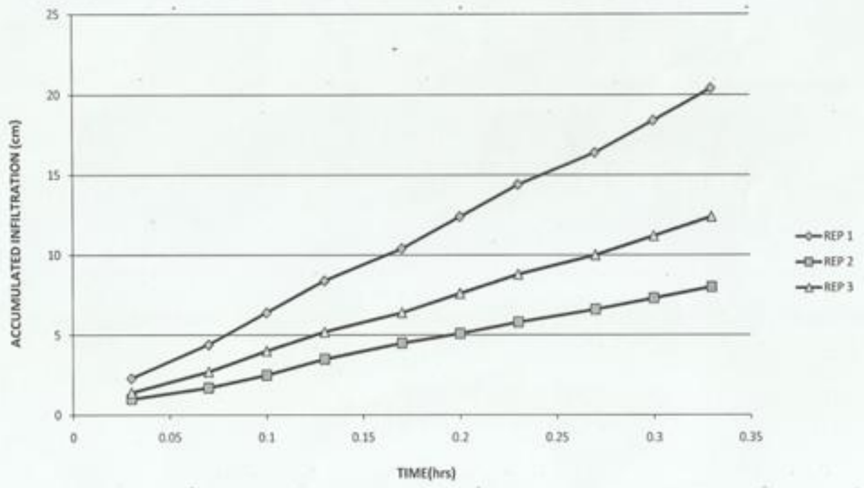

Fig. Graph Of Accumulated Infiltration For The Mid Slope

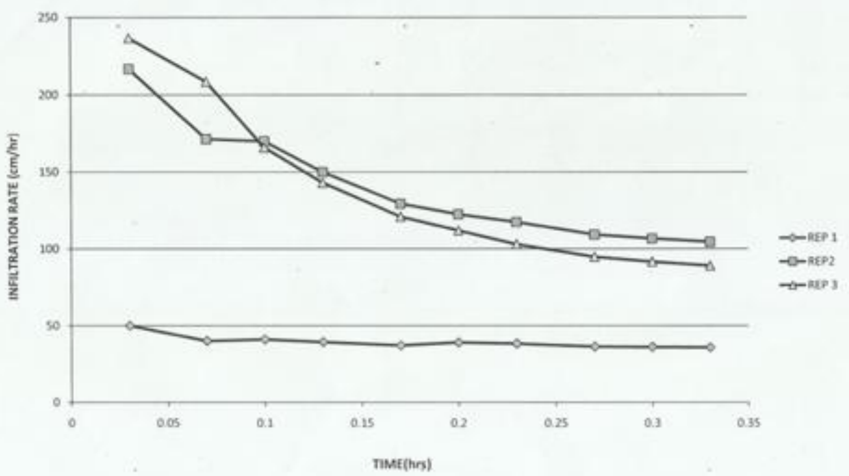

Fig. Graph Of Infiltration Rate For The Foot Slope

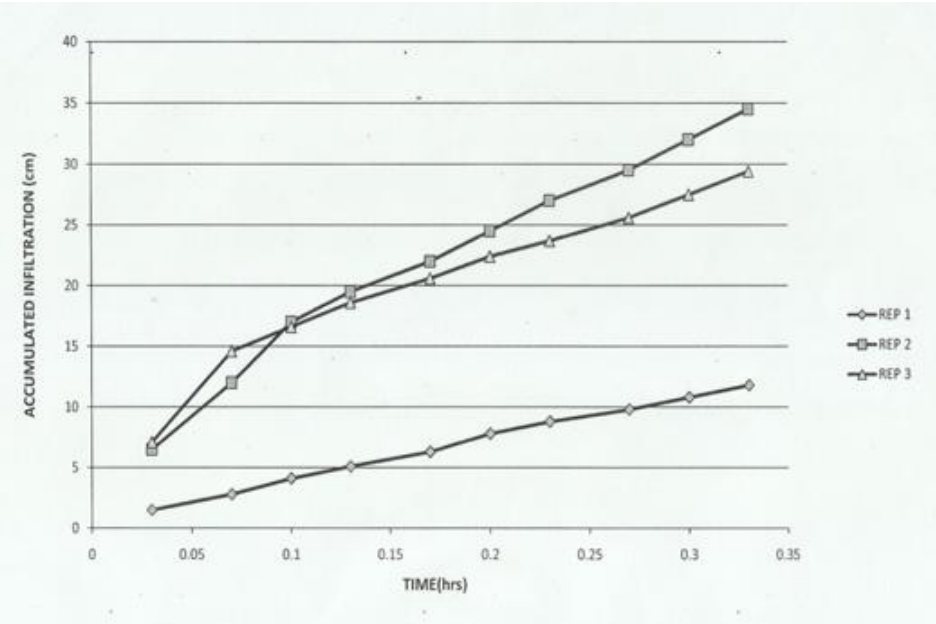

Fig. Graph Of Accumulated Infiltration For The Foot Slope

Table 1. *Physical properties of the study area*

Physiographic Positions	Depth (cm)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	Textural class	Bulk density g/kg
Top slope	0-15 15-30	895.73 916.47	42.33 34.53	61.93 49.00	Sand Sand	1.45 1.42
Mid slope	0-15 15-30	890.00 904.00	49.90 34.83	60.40 61.17	Sand Sand	1.31 1.40
Foot slope	0-15 15-30	789.90 856.73	43.33 34.40	170.13 108.87	Sandy Loam	1.34 1.39
$LSD_{(0.05)}$	18.85*	21.01*	569.1^{NS}		Loamy Sand	0.091*

Table 2. *Correlation and Regression between Basic Infiltration Rate and Selected Soil Properties*

Soil properties	*r*	regression equation
Bulk density	-0.5441	Y=- 42.9x - 503
Clay	-0.2366	Y=-0.230x +94.84
Sand	0.1643	Y=0.168x- 72.34
Organic matter	-0.3256	Y=- 2.216x + 101.9
Porosity	-0.5577	Y=-11.87x + 648.7

REFERENCES

Barrow, C. (1987) Water resources and agricultural development in the tropics. Longman, UK.

Brandy, N. C., and Weil, R.R. (1999). Nature and properties of soil (12thed) Prentice Hall Inc New Jersey

Foth, H.D., (1984). Fundamentals of soil science (7thed). John Willey and Sons New York.

Gee, G.W., and Or, D. (2002) Particle size Analysis. In methods of soil analysis. Dan D.J., and G.C Topps (Ends), part 4 physical methods. Soil science of America book series No 5, ASA and. SSSA Madison, W.1.Pp.225-293.

Grossman, R.B., and Reinsch, T.G. (2002) Bulk density and linear Expansivity.In methods of soil analysis, Dane J.H. and G.C Topps (Eds) part 4, physical methods. Soil sic soc. Am. Book series No. 5. ASA and SSSA Madison W.1.Pp 201-228/

Hendershot, W.H. Lalande, H., and Duquette. M., (1993) soil reaction and exchangeable acidity, in: soil sampling and methods of soil analysis (Caeter M.R., Ed.), Canadian soc. Soil sci. lewis publishers, London Pp 141- 145.

Igbozurike, M.U. (1975) Vegetation types. In: Ofomata, G.E.K: Nigeria in map Easten states. Ettiope publishing house mid west mass communication co-operation, Benin city, Nigeria Pp30-32.

Lal, R (1990) Soil erosion in the tropics, principles and management.

Landon, J.R. (1991) Booker tropical soil manual, John Willey and sons New York.

Mclean, E.Q. (1982) soil pH and lime requirement. In: methods of soil analysis. R.H. Miller and D.R. keeney (Eds), Part 2, 2ndEdn, agron.Monogr. No 9, SAS abs SSA, Madison WL Pp. 199-234.

Michael, A.M. (1978) Irrigation, Theory and practice.Vikas publishers, New Delhi

Nelson, D.N. and Sommers, L.E. (1982) Total carbon, organic carbon amd matter. In methods of soil analysis part 2 (page A.L, R.H., Miller, and D.K., Keeney Edc) Amer Soc. Agron. D.M. madison W.I. Pp 30-32.

Ofomata, G.E.K. (Ed) (1975) Soil, In: Ofomata, G.E.K. Nigeria in maps. Eastern states.Ettiope publishing house mid west mass communication corporation. Benin city Nigeria. Pp 539-579.

Okon, M.A., Osuji, G.E., Onweremadu, E.U., Agim, L.C., Uzoho,B.U., Osuaku, S.K., Ahukaemere, C.M. (2014) “Differences in soil physicochemical properties on a catenary landscape in Owerri, south eastern Nigeria. In: International Journal of Applied Research and Technology vol. 3 NO 10, October 2014, Pp 11-15

Olsen,S.R. and Sommers, I.E. (1982) Soil available Phosphorus. In: Metods of soil analysis part 2. 2nd edition Agron mono.9.ASA and SSA, Madison, USA.

Onweremadu, E.U., Izuogu, O.P., Akamigbo, F.O.R (2010) Aggregation and pedogenesis of seasonally inundated soils of the tropical watershed. Chiang Mai J. Sci. 37 (1): 74-84.

Osuji, G.E. (1984) Water storage, water use and maize yield for tillage systems on a tropical Alfisol in Nigeria. In: Soil and tillage research J.4: 339-348.

Osuji, G.E., Okon, M.A., Chukuwma, M.C., Nwarie I.I., (2010). Infiltration characteristics of soils under selected land practices in Owerri, south eastern Nigeria. In: World journal of Agric. Sci. 6(3) 332-326

Saxton, K.E., Rawls, W.L., Rosenberger J.S. and Papendick, R.I. (1986). Estimating generalized soil water characteristics from texture. Soil sci. soc. Amer. J. 50: 1031-1036.