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MEASUREMENT OF INFILTRATION RATE OF SOIL IN ALVAN IKOKU FEDERAL COLLEGE OF EDUCATION OWERRI FARM

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Abstract

This study measured the rate at which water infiltrates into the soil in the teaching and research farm ofAlvanIkoku Federal College of Education (AIFCE)Owerri. The soil type of the study site was identified to be sandy loam. The farm site was divided into three sections under different uses namely: section A, B, and C and infiltration tests were carried out in the sections respectively. The Double ring Infiltometer was used in conducting the experiment. Values of readings of the time and the corresponding head of water in the Infiltrometer during the measurement were recorded, collated and tabulated. The values were plotted on a graph and the curve showed the rates of infiltration. The computation of the field data gave simple linear models for Sections A , B and C to be y = 28.93 – 0.006x, y = 17.01 – 0.01x and y = 29.46 – 0.021x respectively, for the estimation of infiltration in the three locations, where y is depth and x is time. The rate of infiltration was faster at location C followed by B, while location A recorded the lowest rate. Though the infiltration rates in the three sections are generally within acceptable rates, the differences between the infiltration rates may be traceable to the land use activies in the different sections of the site.

Keywords*: Infiltration Rate, Soil, Measurement, Double ring Infiltrometer, AIFCE farm.*

Introduction

Infiltration is the process by which water on the ground surface enters the soil, Sarva*et al* (2019). Haghiabi, *et al* (2011) defined Infiltration as the water movement from the ground surface into the soil. Soil infiltration refers to the ability of the soil to allow water to move into and through the soil profile and it is an indicator of the soil's ability to allow water movement into and through the soil profile (Phillip, 2012). Bell (2016) defined Soil as an unconsolidated natural set of solid mineral particles that result from physical disintegration and chemical decomposition of rocks which may contain organic matter and voids between the particles, isolated or linked which may contain water and/or air. According to Casagrande (2015) soil can be categorized into sand, clay, silt, peat, chalk and loam types of soil based on the dominating size of the particles within the soil.The larger the soil particles, the faster the infiltration and the smaller the particles the slower the infiltration rates and vice versa (Adeniji et al, 2013). The rate of water flow through the soil is directly related to many hydrological processes namely: ground water recharge, water supply to plants, heat and solute transport, erosion and runoff, Zolfaghari, *et.al* (2012). If the rate is too slow, it can result in ponding in level areas, surface runoff and erosion in sloping areas and can lead to flooding or inadequate moisture for crop production. Sufficient water must infiltrate the soil profile for optimum crop production. Water that infiltrates through

porous soils recharges groundwater aquifers and helps to sustain the base flow in streams. Elemile*et al* (2020) observed that the processing of adequate information of characteristics of soils is essential for designing quality soil management and construction practices on agricultural and urban lands.Different approaches are being used to determine the soil infiltration rate. However, Field measurement of infiltration is often a tedious task, Sarva*et al* (2019), but the infiltration rates can be estimated from models. Many simple analytical equations are available for determination of infiltration. These equations are products of empirical studies. Some of the well-known infiltration equations generated from empirical studies are: Kostiakov Equation 1932, Modified Kostiakov Equation 1978, Horton Equation 1940, etc. Ahaneku, (2011) indicated that clayey soils can have a high infiltration rate when dry and a slow rate when moist (cracks close). Infiltration capacity decreases as the soil moisture content of soil's surface layers increases.

The rate of application of irrigation water is a function of irrigation water demand and the rate of infiltration. It is possible to apply excess water to the field in carrying out irrigation project or apply water at a rate higher than the soil can absorb to the root zone depth at a time. This would normally lead to ponding and temporary saturation which may cause flooding. These possible occurrences are usually as a result of lack of adequate knowledge of the infiltration capacity of the soil. The ponds or water logging will eventually cause environmental pollution, inhibit plant growth and in some cases lead to erosion. However, the knowledge of infiltration capacity of soil can be estimated or predicted. This is usually done by carrying out infiltration experiments or test on the field soil. The determination of infiltration rates leads to obtaining a vivid infiltration capacity record expedient to guard against excess application, flooding or inadequate irrigation schedule. It is against this background that this study was carried out.

The purpose of this study was to determine the rate of infiltration in the Teaching and Research Farm of AlvanIkoku Federal College of EducationOwerri. This will undoubtedly help the users of the farm to avoid excess application of water and at the same time advance soil and water conservation in the farm.

Materials and Method

The study was carried out in the Teaching and Research Farm of AlvanIkoku Federal College of Education Owerri inImo state, Southeastern Nigeria. The latitude of the study location is 5.5002N and longitude is 7.0124E. The study location is within the humid tropics of Nigeria. The annual rainfall ranges from 2250-2500mmand mean annual temperature ranges from 26^0C to 31^0C. The relative humidity is high ranging between 80-90%. The ultisol in the study location was identified to be a combination of sand and loam which make up sandy loam. The land slope is flat gentle to undulating, slightly affected by erosion. With these conditions, the determination of infiltration is necessary so as to avoid leaching or erosion of the soil while irrigation is being carried out.

The study is an experimental research study carried out in a farm. A reconnaissance survey was carried out in the farm to determine the position for the infiltration experiments to be carried out. The farm was divided into three (3) blocks. Three (3) identified locations were marked and cleared and made ready for the experiment. The surfaces were also made plain without disturbing the soil surface. For comparison and accuracy, measurements were taken at the 3 different locations selected from different sections of the farm under different uses and management namely: Crop section (A), Greenhouse section (B), andPoultry section (C).Materialsused in the infiltration measurement include:Mallet, harmer, rake, Measuring rule, Polythene sheet, Stopwatch, water containers, Double ring

Infiltrometer (30-60 cm diameter), and Distilled water

Soil test: the findings of the study onthe soil physical and chemical properties of the study site by Poly-Mba *et al,* (2019) were adopted.

Infiltration measurement: The Double Ring Infiltrometer method was adopted in conducting the experiment.This method was adopted by Elemile*et al* (2020). The Infiltrometer was driven 5cm into the soil and a polythene sheet was used to cover the inner ring. The outer ring was then filled with water to a particular depth. Water poured into outer ring was allowed to infiltrate before pouring water into the inner ring. The plastic sheet was removed from the inner ring as water was being poured and recording of depth with time started.At the end of the experiment, the data generated in the process was collated and recorded. The depth of infiltration in millimeters (mm) was recorded against the time taken in seconds (sec). Graph of depth of infiltration in *cm* was plotted against the time taken in minutes. The infiltration rates of the locations were interpreted with the aid of the curve of the graph and they were also used to draw conclusion.

Results and Discussion

Table 1: Selected Properties of the Soil

Parameter	Values
Sand	72.5%
Silt	12%
Clay	15.5%
Organic matter	2.786%
pH in water	5.09
Textural class	Sandy loam

Table 2: Infiltration Data for A

Depth (cm)	Time (sec)	Cumulative Depth (cm)	Cumulative Time (sec)
34	0	0	0
32	100	66	100
30	108	96	208
28	121	124	329
26	136	150	465
24	152	174	617
22	172	196	789
20	194	216	983
18	226	234	1209
16	271	250	1480
14	293	264	1773
12	361	276	2134
10	421	286	2555
08	490	294	3045
06	500	300	3545
04	530	304	4075
02	566	306	4641

Table 3: Infiltration Data for B

Depth (cm)	Time (sec)	Cumulative Depth (cm)	Cumulative Time (sec)
20	0	0	0
18	63	38	63
16	68	54	131
14	90	68	221
12	112	80	333
10	152	90	485
08	196	98	681
06	275	104	956
04	335	108	1291
02	365	110	1656

Table 4: Infiltration Data for C

Depth (cm)	Time (sec)	Cumulative Depth (cm)	Cumulative Time (sec)
34	0	0	0
32	28	66	28
30	28	96	56
28	41	124	97
26	50	150	147
24	56	174	203
22	65	196	268
20	72	216	340
18	90	234	430
16	106	250	536
14	106	264	642
12	106	276	748
10	119	286	867
08	130	294	997
06	142	300	1139
04	161	304	1300
02	142	306	1442

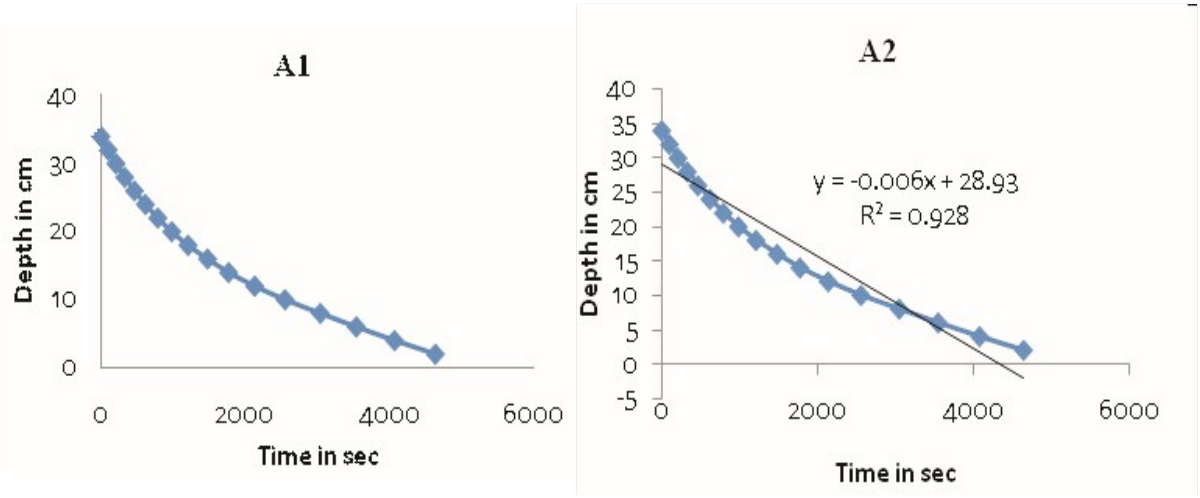

Figure 1. Rate of Infiltration with Time in Crop Section

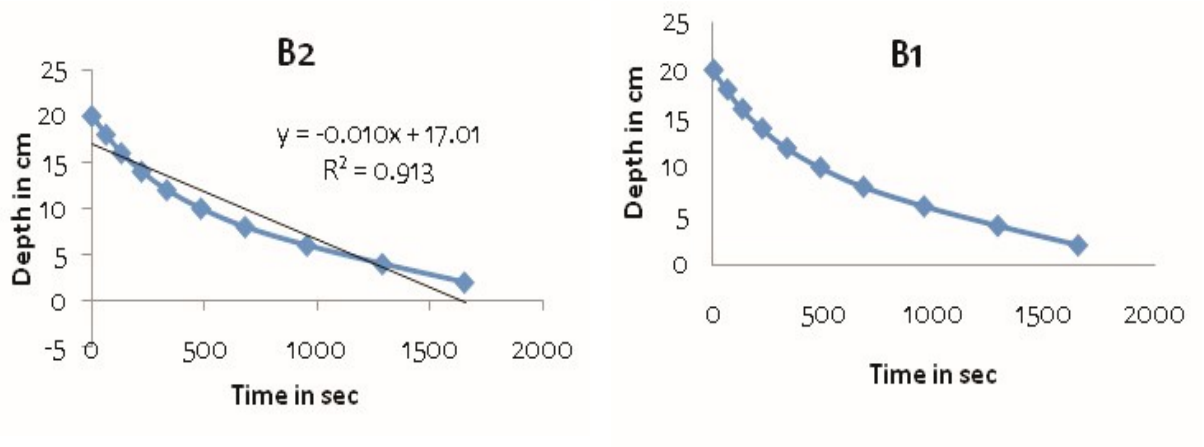

Figure 2. Rate of Infiltration with Time in Green House Section

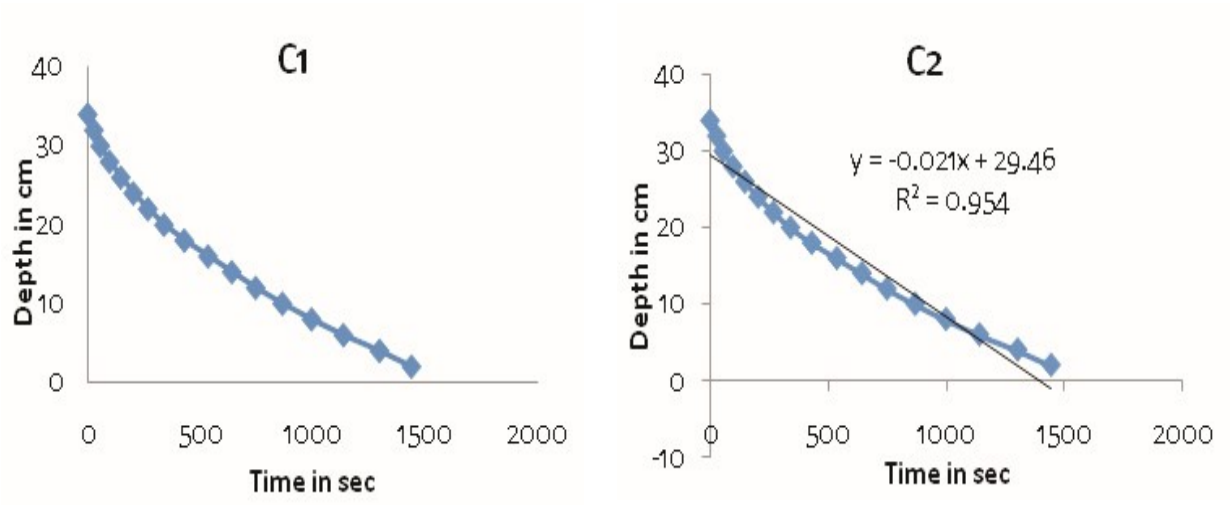

Figure 3. Rate of Infiltration with Time in Poultry Section

The infiltration rate is an indication of the susceptibility of the soil to runoff or ponding. The study compared the rates of infiltration in the different locations of the study site under different uses. Table 1 shows selected soil properties of the study site. The textural class of the ultisol is sandy loam. Tables 2 to 4 show the infiltration measurement values. The data showed clear differences in the rates of infiltration. The curves, A, B and C of the graphs show the relationship between change in depth of water level in the Infiltrometer and time during measurement.The curves show that as time or duration increases, the vertical height or head of water decreases. This shows the porosity and permeability levels of the different sections of the farm. For Sections A, B and C, $y = 28.93 - 0.006x$, $y = 17.01 - 0.01x$ and $y = 29.46 - 0.021x$ respectively, where *y is* head in *cm* of water and *x*istimes in *sec*. This linear relationship between *y*and *x* gives a clue to how fast or slow water infiltrates with time as water applications proceeds and percolation occurs. Whereas the simple linear regression may not give an absolute result, it provides sufficient guide and information on the surface phenomenon of infiltration in the study site. Therefore, the solutions of the equations can guide decisions on irrigation application rates.Thoughthe sitesoil, being preponderantly sandy loam, allowed for infiltration at moderate ratesas shown by the curves, the differences in the rates can be attributed to land use in the different sections of the farm. There will hardly be a water logging occurrence in the farm during an irrigation exercise owing to the head to time ratio for the infiltration process. Basically, the infiltration rate in the study site is good and poses no threat or risk of water logging.

Conclusion

The interpretation of the curve of the graph showed the infiltration rate of the study site and they were also used to draw conclusion.From the tables and rate curve, the study site soil has moderate infiltration rate and will hardly be water logged. **Irrigation scheduling of the farm will** therefore not be difficult but will depend largely on the type of crop and the crop water demand. Based on the findings of the study, the use of sprinklers in the farm will be quite beneficial in the site though controlled surface irrigation is equally applicable. The findings of this study can be employed in carrying out irrigation projects and schemes in the farm and the surrounding soils.

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