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Orginal Article

Seasonality Effect of Infiltration Rates of Some Selected Soil Types of Soilin North Central Area of Nigeria

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Abstract

Infiltration experiments were conducted to investigate seasonality effect of infiltration rates on some major soils in Gidan Kwanu area of the central area of Nigeria. The major soil found in this area is the sandy loam type with a sparse distinction of the sandy–clay soil and sandy soils. The infiltrometer rings will be placed randomly on each soil type and measurement taken to the nearest centimetre. The rings will be driven into the ground by hammering a wooden bar placed diametrically on the rings to prevent any blowout effects around the bottoms of the rings. In areas where ridges and furrows existed, the inner rings will always be placed in the furrow. The sandy soil had the highest rate of infiltration rate of 11.26 cm/hr and 19.35 cm/hr for the wet and dry seasons respectively while disturbed sandy soil hard the lowest infiltration rate of 8.18 cm/hr during the wet season and disturbed loam soil had the lowest infiltration rate of 8.61 cm/hr for dry season. Infiltration capacity was reasonably stable over the two seasons considered, thus infiltration tests have a role in assessing the long term risk of overland flow and the associated pollution hazard.

Keywords: *Bulk density, Hydraulic conductivity, Infiltration capacity, Soil porosity, Soil profile, Void space*

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INTRODUCTION

As a watershed begins to accept precipitation, surface vegetation and depressions intercept and retain a portion of that precipitation. Interception, depression storage and soil moisture each contribute to groundwater accretion, which constitutes the basin recharge (Nathanail and Bardos, 2004). Precipitation that does not contribute to basin recharge is direct runoff (Motha and Wigham, 1995). Direct runoff consists of surface runoff (overland flow) and subsurface runoff (interflow), which flows into surface streams. The basin recharge rate is at its maximum at the beginning of a storm, and decreases as the storm progresses (Morita and Yen, 2002).

A water droplet incident at the soil surface has just two options: it can infiltrate the soil or it can run off. This partitioning process is critical. Infiltration, and its complement runoff, is of interest to hydrologists who study runoff generation, river flow, and groundwater recharge. The entry of water through the surface concerns soil scientists, for infiltration replenishes the soil's store of water. The partitioning process is critically dependent of the physical state of the surface. Furthermore, infiltrating water acts as the

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vehicle for both nutrients and chemical contaminants.

Infiltration rate data of soil can be used to supplement other soil information which should help soil scientists, engineer, hydrologists and other deal more precisely with a wide spectrum of water resources management and conservation problem (Ahmed, 1981) different types of soil are known to have different water intake rates. Movement of the water through the soil profile tells a lot about the pore sizes and permeability; the larger the pore sizes of the soil the higher the rate at which water is taken in while the reverse is the case for smaller pore sizes. In some cases, the pore sizes can be large but the rate which water moves through the profile can be slow, this may depends on presence of air within the profile and where such exist, there will be a sudden upstroke of water releasing the air into the atmosphere and then the process of infiltration will continue.

Layered soils are known to induce unstable flow when a fine-textured region lies over a coarse-textured one, (Roats, 1973). During infiltration into dry soil layered in this manner, water cannot enter the coarse-textured zone until the pressure has built up sufficiently to wet the layer pore. If this occurs at discrete locations along the wetting point, the new wetted channels in the coarse-textured zone may become conduits for all the water entering from above. These narrow-flow channels, called finger can persist through the entire coarse-textured zone. As the flow paths become smaller which explains partly the decline of the infiltration rate in time. By the time infiltration rate is constant, a pronounced transition zone is established with nearly uniform moisture content close to saturation. Pressure difference here is smaller and the water movement is dominated by the gravity force. The final infiltration rate thus becomes approximately equal to the saturated hydraulic conductively of the soil.

The introduction of modern, and increasingly heavier and more powerful farm machinery has in doubt contributed to improved crop yields, it has, nevertheless, been a major factor in promoting soil degradation where adequate care is not taken. Although compacted layers may occur in soils naturally as a result of evolutionary processes, generally they are man-induced and therefore• are the target of our concern. Vehicular factors such as axle load, wheel width, and frequency of operation are related to compaction (Hakansson, 1990); the effect is greater when the soil has the optimum moisture content for compaction. Indeed, there are situations where some compaction may benefit crop growth depending on growing season precipitation. In a relatively wet season, compaction reduced grain yield compared with that on a non-trafficked soil, whereas in a drier year the reverse was true (Voorhees et al., 1985). The rate of infiltration is important because if the rate is too slow, the retention pond may overflow and cause property damage and threaten public safety, and if the infiltration rate is too fast, water-quality treatment and spill containment are compromised

The objective of this study is to ascertain the seasonality effect of infiltration rates of some soils of Gidan Kwanu in the north central area of Nigeria

MATERIAL & METHODS

Study Area

The permanent site of the Federal University of Technology, Minna with a total land mass of eighteen thousand nine hundred hectares (18,900 ha) located along kilometre 10 Minna–Bida Road, South–East of Minna in Bosso Local Government Area of Niger State. It has a horse – shoe shaped stretch of land, lying approximately on longitude of 06^0 28’ E and latitude of 09^0 35’ N. The site is bounded Northwards by the Western rail line from Lagos to the northern part of the country and the eastern side by the Minna–Bida Road and to the North–West by the Dagga hill and river Dagga. The entire site is drained by rivers Gwakodna, Weminate, Grambuku, Legbedna, Tofa and their tributaries. They are all seasonal rivers and the most prominent among them is the river Dagga. The most prominent of the features are river Dagga, Garatu Hill and Dan Zaria dam (Musa, 2003).

The major soil found in this area is the sandy loam type with a sparse distinction of the sandy–clay soil and sandy soils. This has so far encouraged the residents of Minna metropolis and neighbouring villager to use the land for agricultural activities such as farming and grazing by the nomadic cattle rearers (Musa, 2003).

Infiltration measurement

The infiltrometer rings were placed randomly from each other and the measurement were taken to the nearest centimetre. The rings were driven into the ground by hammering a wooden bar placed diametrically on the rings to prevent any blowout effects around the bottoms of the rings. In areas where ridges and furrows existed, the inner rings were placed in the furrow. A mat/jute sack was spread at the bottom of the inner and outer compartments of each infiltrometer to minimize soil surface disturbance when water was

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been poured into the compartments. In grass–covered areas, they were cut as low as possible with a cutlass so that the float could have free movement and care was taken not to uproot grasses. Four sets (4) of infiltration measurements were conducted at each location of which an average will be taken later.

According to Musa (2003), water was collected from nearby canals using jeri-cans and buckets. The water was therefore poured into the infiltrometer compartments simultaneously and as quickly as possible. As soon as the jeri-cans/buckets are emptied, the water level for the inner cylinder was read from the float (rule) and the local time will be noted. Repeated readings were taken at intervals of 0, 1, 2, 5, 10, 15, 20, 30, 45, 60, 75, 90, 100, 120, 150 and finally at 180 minutes. The two cylinder compartments were refilled from time to time when the water level drops below half way. Certain time was allowed before starting another replicate measurement that no two infiltrometer will require reading the same time.

RESULTS & DISCUSSION

Seasonality difference in infiltration of water into some soils is of paramount importance to the agriculture and construction world. Thus soil compaction and its effects on crop growth have come into the focus of research in the past decade. Tables 1 and 2 presents the infiltration rates and cumulative infiltration for disturbed and undisturbed soils during the wet season while Tables 3 and 4 presents the infiltration rates and cumulative infiltration for disturbed and undisturbed soils during the dry season for the five different soil types established within the Gidan Kwanu soil of the Federal University of Technology, Minna.

Infiltration rate usually shows a sharp decline with time from the start of the application of water. A constant rate is approached after a sufficiently large time; this is referred to as the steady-infiltration rate as observed in Table 1 and 3 respectively. Infiltration rate was measured using the double ring infiltrometer and the rate of fall of water was measured in the inner ring while a pool of water was maintained at approximately the same level in the outer ring to reduce the amount of lateral flow from the inner ring.

It was observed that there is a difference in suction head in the soil; thus when the infiltration rate was been carried out, the top layer of the soil became wetter than the lower layers. Due to the difference in the suction head, downward forces (due to the suction head or capillary effect and pressure head or moisture gradient from the saturated top layer) with the gravity force will act on the

water and force the water to infiltrate into the soil. At the start of the infiltration, the downward forces are large compared with the flow resistance of the soil thus water enters the soil rapidly. As the time of infiltration increases, the resistance that is caused by swelling of the various soil particles and entrapped air increases. Therefore, there is not much difference between the values of downward forces and thus the rate of infiltration reduces. When the downward forces and resistance have equalized, the rate of infiltration becomes constant and stabilizes. The results presented in Tables 1 to 4 shows that the infiltration rate varies from one soil to another. The sandy soil had the highest rate of infiltration rate of 11.26 cm/hr and 19.35 cm/hr for the wet and dry seasons respectively while disturbed sandy soil hard the lowest infiltration rate of 8.18 cm/hr during the wet season and disturbed loam soil had the lowest infiltration rate of 8.61 cm/hr for dry season. The soil properties and slope may be contributing factors.

Soil porosity is known to have a close relationship with the hydraulic conductivity of the soil. Hydraulic conductivity is one of the flow parameters in infiltration analysis. The higher the porosity the higher the higher the rate of infiltration. The rate at which water is infiltrated into the soil increases rapidly when the void ration is more than one. It was also observed that the higher the bulk density the lower the rate at which water is infiltrated into the soil and vice versa. It can also be concluded that the higher the density the denser the soil and the lesser the pore spaces and the most difficult for water to pass through thus reaching the infiltration rate.

Table 1 and 2 reveal that the basic intake rate is almost similar within the soil profiles representing this zone and the values of infiltration rate ranged from 7.65 to 11.26 cm/hr while the cumulative infiltration ranged between 12.90 to 22.35 cm for wet season and distinguished as low infiltration class because of the soil moisture content as that time. Table 3 and 4 present the average infiltration rate observed during the dry season with the infiltration rate ranging between 8.61 and 19.35 cm/hr and the cumulative infiltration ranging between 7.24 and 16.15 cm. This period is classed as the high infiltration period as the moisture content for the various soils were extremely low thus giving room for high rate of water intake. Though, in some of the soils, it was observed that water intake rate reached its climax under 3 hours

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which could be as a result of the nature of the underlay of soil and the shallow depth of the water table. Such was observed in undisturbed sandy loam soil and disturbed clay soil.

Furthermore, the values of infiltration rate were high in the first few minutes, the basic infiltration rate displayed a steady state at close to 3 hours which when compared with the works of Musa and Egharevbe (2009), Eze 2000 and that of Ahmed and Duru (1982) shows a very high level of correlation; though the conditions of operation were similar thus the results obtained were very similar. It is important to note that the level of soil disturbance which was observed in the works of Musa (2003) were almost the same as the disturbed soils were basically used as farm lands. The highest infiltration rate of this soil profiles might be attributed to the high sand content over 90.0%and low clay content. The low infiltration rate in some of the soil profile might be attributed to the particle size distribution and other physical properties in the different layers this behaviour is attributed to the fact that the coarse textured soils in the upper soil layers have higher macro pores than the fine textured layers of the bottom soil layers. It is important to note that the higher the pore spaces the higher the rate of infiltration. This was observed in coarse textured soils which have higher macrospores than the fine textured ones. The results clarified that, as soil sand content increased, water movement increases due to the relative increase in soil pores. It was observed that the infiltration rate of disturbed soils for both seasons when compared with that of the undisturbed soils were higher which may be due to the fact that more pore spaces had been created, the area may have a high water table or the area may be under laid by strata of rocks which may prevent the water from moving down into the soil profile as observed by Musa (2003).

When soils are highly degraded, actual rainfall limits growth and production of vegetation since most water infiltrates into the soils. Therefore, the infiltration capacity is considered as a key property of such semi-arid soils. A high infiltration capacity prevents surface runoff and soil erosion, which are common phenomena in some areas where sandy soil is predominant. The entry of water depends on both the matric and gravitational potentials and on soil physical properties governing it. Skaggs *et al*. (1983) found that infiltration rates tended to increase with coarser deep soil profile. However, in as much as soil profiles of most natural soil are seldom uniform, the effect of stratification on infiltration rate is often spectacular.

Intra-site variation in steady infiltration rates was substantial and varied widely between sites and seasons. Regression analysis of the infiltration rate shows a significant correlation between the infiltration rates for the various soils and between seasons. The regression analysis for the various soils is presented in Table 5 below. It was also observed that various forms of equation of the form of $Y = MX + C$ for the various condition and types of soils considered for this study were presented while Table 6 shows the regression analysis for the cumulative infiltration for the soils and there condition with the corresponding equation of the form $Y = MX + C$.

The difference in mean infiltration rate between the seasons was small (10 mm hr-1) and was not statistically significant ($P < 0.05$). At each of the sites in which measurements were repeated in the same field the mean infiltration rates of sites were significantly related for the dry season and very significantly related during the wet season. From the results available this shows that the soil structure and associated pore configuration were reasonably stable over the two seasons.

Infiltration rates were substantially lower during the wet season than in the dry season. The observed cumulative infiltration for the wet season was about two third of that which was observed during dry season though in some cases the significant difference was very minimal when the cumulative infiltration for the two seasons were compared. The infiltration rate during the wet season showed a better measure of the steady rate. The differences between seasons were statistically very significant. Regression analyses did not show a relationship between steady infiltration rate and initial moisture content. The stability of infiltration rates between the seasons shows an overall stability of soil structure. Seasonal changes in soil structure, especially in the subsoil, are unlikely to be significant. Abrupt changes in infiltration can occur in soils composed of swelling clays.

There was a clear difference in the moisture content between the wet and dry season, although regression analysis did not reveal a relationship between infiltration rate and the moisture content at the surface, the change in moisture regime from wet to dry may be attributed to the seasonal difference in infiltration rates.

Seasonal changes in soil structure, especially in the subsoil, are unlikely to be significant. Infiltration tests are a poor discriminate of soil properties in winter because infiltration rates are influenced more by hydrologic regime than by soil properties.

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Since rainfall is generally intermittent in the North central area of Nigeria the intensity over hourly periods is more appropriate than daily rates to evaluate the risk of overland flow. The rainfall data over a return period of 25 years is presented in appendix 1 which is a representative of the average rainfall intensity 228 mm/hr. Obviously, the expected rainfall or the maximum liquid application rate should not exceed the infiltration capacity if surface runoff is to be avoided. In the dry season the steady infiltration rates ranges between 8.61 cm/hr and 19.35 cm/hr while that of the wet season ranged between 7.43 cm/hr and 11.26 cm/hr for the various types of soil that was considered. This implies that, except on impermeable soils, the risk of overland flow in wet season are almost negligible on soils that are wettable and lack visible evidence of abnormal compaction by machines or animals. The steady infiltration rate defines a minimum absorption capacity. At any given time, especially during the wet season, the soil will be capable of storing additional water both in and on the soil; the amount will depend on the antecedent weather conditions and on micro relief. This reduces still further the actual risk of overland flow.

CONCLUSION

1. Infiltration capacity was reasonably stable over the two seasons considered and thus infiltration tests have a role in assessing the long term risk of overland flow and the associated pollution hazard.
2. There was a pronounced seasonal effect on the steady infiltration capacity during the dry season when compared with the wet season using the regression analysis obtained in Tables 5 and 6. The R^2 values for all the infiltration capacity during the wet season did not exceed that of the dry season. When the average obtained values of infiltration rates were compared with irrigation rates of 0.5 cm/ha or 0.25 cm/hr as permitted by the Code of Good Practice was exceeded by the infiltration capacity of some soils, including free draining soils, during the wet season. Consequently there is a significant risk of overland flow during the wet season for some of the areas that were tested if there is a slight change in the rainfall intensity.

Substantial variation occurs within sites and the variation is greater during the wet season than the dry season.

It is recommended that

1. infiltration tests are carried out during the dry season as tests conducted during the wet season do not reflect the stability of the various soil characteristics and
2. that the tests should be performed over a longer period of time for a particular type of soil.

To assess the risk of overland flow over the whole year, additional information will be required on the duration and degree of wetness for each of the soil type under consideration.

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Table 1.Average infiltration rate of the various types of soils under the disturbed and undisturbed condition during the rainy season

Time (Mins)	Undisturbed Sandy Soil	Disturbed Sandy Soil	Undisturbed Sandy Loam	Disturbed Sandy Loam	Undisturbed Clay	Disturbed Clay	Undisturbed Loam	Disturbed Loam	Undisturbed Sandy Clay	Disturbed Sandy Clay
0	25.00	20.00	20.00	20.00	16.92	16.00	20.00	20.00	18.00	19.00
1	23.95	18.45	19.80	19.50	15.65	15.90	18.55	18.55	16.50	17.45
2	22.35	16.35	18.70	18.40	14.55	13.67	16.85	16.25	14.34	15.35
5	20.25	14.65	16.65	16.35	13.60	12.99	14.25	14.65	12.56	12.90
10	17.85	12.27	14.95	14.75	12.45	10.75	12.10	13.75	11.23	10.68
15	15.33	10.15	13.65	13.25	11.65	9.67	10.80	11.90	9.25	8.45
20	13.95	8.75	12.70	12.50	10.35	7.58	9.56	9.40	8.45	6.85
30	9.65	5.85	10.55	10.35	8.29	6.45	8.45	8.60	7.60	5.90
45	7.85	4.75	8.25	8.59	6.85	5.30	7.65	7.30	6.40	4.35
60	5.24	3.95	7.10	6.10	4.75	4.70	6.65	6.40	5.80	3.68
75	4.10	3.15	6.45	5.35	3.65	3.85	5.70	5.20	4.30	2.90
90	3.45	2.85	5.80	3.80	3.10	3.20	4.90	4.80	4.20	2.65
100	3.05	2.65	5.20	3.10	2.85	3.10	4.50	4.50	4.13	2.35
120	2.85	2.35	4.30	2.80	2.50	3.10	4.20	4.50	4.10	2.10
150	2.65	2.35	4.10	2.40	2.50	3.10	4.10	4.50	4.10	2.10
180	2.65	2.35	4.10	2.40	2.50	3.10	4.10	4.50	4.10	2.10
Average infiltration rate per soil type/condition	11.26	8.18	10.77	9.98	8.26	7.65	9.52	9.68	8.44	7.43

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Table 2. Average Cumulative infiltration of the various types of soils under the disturbed and undisturbed condition during the rainy season

Time (Mins)	Undisturbed Sandy Soil	Disturbed Sandy Soil	Undisturbed Sandy Loam	Disturbed Sandy Loam	Undisturbed Clay	Disturbed Clay	Undisturbed Loam	Disturbed Loam	Undisturbed Sandy Clay	Disturbed Sandy Clay
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.05	1.55	0.20	0.50	1.27	0.10	1.45	1.45	1.50	1.55
2	2.65	3.65	1.30	1.60	2.37	2.33	3.15	3.75	3.66	3.65
5	4.75	5.35	3.35	3.65	3.32	3.01	5.75	5.35	5.44	6.10
10	7.15	7.73	5.05	5.25	4.47	5.25	7.90	6.25	6.77	8.32
15	9.67	9.85	6.35	6.75	5.27	6.33	9.20	8.10	8.75	10.55
20	11.05	11.25	7.30	7.50	6.57	8.42	10.44	10.60	9.55	12.15
30	15.35	14.15	9.45	9.65	8.63	9.55	11.55	11.40	10.40	13.10
45	17.15	15.25	11.75	11.41	10.07	10.70	12.35	12.70	11.60	14.65
60	19.76	16.05	12.90	13.90	12.17	11.30	13.35	13.60	12.20	15.32
75	20.90	16.85	13.55	14.65	13.27	12.15	14.30	14.80	13.70	16.10
90	21.55	17.15	14.20	16.70	13.82	12.80	15.10	15.20	13.80	16.40
100	21.95	17.35	14.80	17.40	14.07	12.90	15.50	15.50	13.87	16.70
120	22.15	17.65	15.70	17.70	14.42	12.90	15.80	15.50	13.90	16.95
150	22.35	17.65	15.90	18.10	14.42	12.90	15.90	15.50	13.90	16.95
180	22.35	17.65	15.90	18.10	14.42	12.90	15.90	15.50	13.90	16.95
Average cumulative infiltratin	13.74	11.82	9.23	10.18	8.66	8.35	10.48	10.33	9.56	11.59

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Table 3. Average infiltration rate of the various types of soils under the disturbed and undisturbed condition during the dry season

Time (Mins)	Undisturbed Sandy Soil	Disturbed Sandy Soil	Undisturbed Sandy Loam	Disturbed Sandy Loam	Undisturbed Clay	Disturbed Clay	Undisturbed Loam	Disturbed Loam	Undisturbed Sandy Clay	Disturbed Sandy Clay
0	35.50	25.50	19.00	20.00	17.45	22.45	20.00	20.00	23.50	24.00
1	32.40	22.40	18.00	19.15	16.10	21.10	17.35	18.45	20.40	23.00
2	30.25	20.25	16.30	18.45	15.40	19.74	14.25	16.28	18.00	21.50
5	26.20	18.20	14.50	16.35	14.50	18.54	13.25	14.53	16.50	19.65
10	24.10	17.10	13.40	14.75	13.40	16.24	12.10	12.59	14.40	17.10
15	22.40	15.40	11.25	12.25	12.40	14.65	10.45	9.45	12.50	15.55
20	21.40	13.40	10.10	10.55	11.40	12.34	9.10	8.18	10.40	13.45
30	21.40	11.40	8.60	8.95	10.40	10.40	8.35	8.35	8.40	11.20
45	19.50	9.50	7.40	6.75	9.10	8.21	7.55	6.55	6.30	8.95
60	18.20	8.20	6.20	5.35	8.50	6.75	6.20	5.49	5.50	6.25
75	14.40	6.40	5.40	4.65	7.55	5.15	5.00	4.59	4.20	5.15
90	12.50	5.50	4.30	3.85	6.50	4.50	4.10	4.10	3.50	4.25
100	10.10	5.10	3.50	3.15	5.40	3.75	3.10	3.57	3.30	3.95
120	8.50	4.50	2.40	3.05	5.50	2.85	2.50	2.35	2.50	3.10
150	6.40	4.40	2.40	2.85	5.20	2.85	2.20	2.10	2.10	2.85
180	6.40	4.40	2.40	2.85	5.20	2.85	2.20	2.10	2.10	2.85
Average infiltration rate	19.35	11.98	9.07	9.56	10.25	10.77	8.61	8.67	9.60	11.43

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Table 4. Average Cumulative infiltration of the various types of soils under the disturbed and undisturbed condition during the dry season

Time (Mins)	Undisturbed Sandy Soil	Disturbed Sandy Soil	Undisturbed Sandy Loam	Disturbed Sandy Loam	Undisturbed Clay	Disturbed Clay	Undisturbed Loam	Disturbed Loam	Undisturbed Sandy Clay	Disturbed Sandy Clay
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	3.10	3.10	1.00	0.85	1.35	1.35	2.65	2.65	3.10	1.00
2	5.25	5.25	2.70	1.55	2.05	2.05	5.75	5.75	5.50	2.50
5	9.30	7.30	4.50	3.65	2.95	2.95	6.75	6.75	7.00	4.35
10	11.40	8.40	5.60	5.25	4.05	4.05	7.90	7.90	9.10	6.90
15	13.10	10.10	7.85	7.75	5.05	5.05	9.55	9.55	11.00	8.45
20	14.10	12.10	9.00	9.45	6.05	6.05	10.90	10.90	13.10	10.55
30	14.10	14.10	10.50	11.05	7.05	7.05	11.65	11.65	15.10	12.80
45	16.00	16.00	11.70	13.25	8.35	8.35	12.45	12.45	17.20	15.05
60	17.30	17.30	12.90	14.65	8.95	8.95	13.80	13.80	18.00	17.75
75	21.10	19.10	13.70	15.35	9.90	9.90	15.00	15.00	19.30	18.85
90	23.00	20.00	14.80	16.15	10.95	10.95	15.90	15.90	20.00	19.75
100	25.40	20.40	15.60	16.85	12.05	12.05	16.90	16.90	20.20	20.05
120	27.00	21.00	16.70	16.95	12.15	12.15	17.50	17.50	21.00	20.90
150	29.10	21.10	16.70	17.15	12.45	12.45	17.80	17.80	21.40	21.15
180	29.10	21.10	16.70	17.15	12.45	12.45	17.80	17.80	21.40	21.15
Average cumulative infiltration	16.15	13.52	10.00	10.44	7.24	7.24	11.39	11.39	13.90	12.58

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Table 5. Regression analysis of Infiltration rates for the various soils of Gidan Kwanu

S/No	Type of Soil and condition of soil		Seasonality values of R^2		Seasonality equation of the form y = Mx +C	
	Soil	Condition	Dry	Wet	Dry	Wet
1	Sand	Undisturbed	0.862	0.731	$Y = -0.147X + 18.36$	$Y = -0.125X + 18.36$
		Distrubed	0.745	0.649	$Y = -0.106X + 17.98$	$Y = -0.088X + 13.17$
2	Sandy loam	Undisturbed	0.782	0.779	$Y = -0.088X + 14.08$	$Y = -0.090X + 15.87$
		Distrubed	0.810	0.738	$Y = -0.102X + 15.73$	$Y = -0.096X + 14.98$
3	Clay	Undisturbed	0.814	0.781	$Y = -0.066X + 14.01$	$Y = -0.081X + 12.87$
		Distrubed	0.778	0.672	$Y = -0.109X + 16.96$	$Y = -0.069X + 14.98$
4	Loam	Undisturbed	0.752	0.682	$Y = -0.084X + 13.36$	$Y = -0.077X + 13.90$
		Distrubed	0.714	0.674	$Y = -0.088X + 13.64$	$Y = -0.077X + 14.06$
5	Sandy Clay	Undisturbed	0.715	0.640	$Y = -0.104X + 15.51$	$Y = -0.066X + 12.18$
		Distrubed	0.771	0.622	$Y = -0.119X + 18.16$	$Y = -0.080X + 11.99$

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Table 6. Regression analysis of Infiltration rates for the various soils of Gidan Kwanu

S/No	Type of Soil and condition of soil		Seasonality values of R^2		Seasonality equation of the form Y = Mx +C	
	Soil	Condition	Dry	Wet	Dry	Wet
1	Sand	Undisturbed	0.862	0.731	$Y = 0.147X + 7.810$	$Y = 0.125X + 6.631$
		Distrubed	0.745	0.649	$Y = 0.106X + 7.512$	$Y = 0.125X + 6.822$
2	Sandy loam	Undisturbed	0.780	0.779	$Y = 0.089X + 4.957$	$Y = 0.090X + 4.121$
		Distrubed	0.738	0.822	$Y = 0.096X + 5.016$	$Y = 0.105X + 4.219$
3	Clay	Undisturbed	0.823	0.781	$Y = 0.067X + 3.410$	$Y = 0.081X + 4.044$
		Distrubed	0.823	0.672	$Y = 0.067X + 3.410$	$Y = 0.069X + 4.453$
4	Loam	Undisturbed	0.752	0.680	$Y = 0.084X + 6.638$	$Y = 0.077X + 6.098$
		Distrubed	0.752	0.674	$Y = 0.084X + 6.638$	$Y = 0.77X + 5.932$
5	Sandy Clay	Undisturbed	0.715	0.640	$Y = 0.104X + 7.984$	$Y = 0.060X + 5.816$
		Distrubed	0.771	0.624	$Y = 0.119X + 5.838$	$Y = 0.081X + 7.002$

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