Journal of Agroecology and Natural Resource Management
p-ISSN: 2394-0786, e-ISSN: 2394-0794, Volume 2, Issue 5; July-September 2015 pp. 382-387

http://www.krishisanskriti.org/Publication.html

The Study of Infiltration Charactersitics of Locally Soil (N.I.T Kurukshetra Campus)

Rahul Agarwal[1], Parveen Sihag[2] and N.K. Tiwari[3]

[1,2,3]*N.I.T Kurukshetra*
E-mail: [1]rahulagarwal3149@gmail.com, [2]parveen12sihag@gmail.com, [3]nand_nitk@rediffmail.com

Abstract—*A Study was attempted to assess the infiltration rate for NIT Kurukshetra campus soil. Ten Different locations was selected in the study area in order to examine the infiltration rate of locally available soil.Mini Disc infiltrometer was used to carry out the experimental study. Infiltration were taken for 0 to 17 minutes of 1 min. interval. From different locations, sample was collected for determination of Dry density, Field density and Water content. The field observation and graphical representation indicates the variation of infiltration of locally available soil and their hydraulic conductivity. So that the location 3 has highest infiltration with K = 0.000371475 cm/s hydraulic conductivity.The soil of N.I.T kurukshetra is low permeable to premeable. Although there was variation in infiltration .*

Keywords*: Infiltration, water content, dry density,saturated hydraulic conductivity.*

1. INTRODUCTION

Infiltration is the process by which water is seeped into the soil from the surface. Infiltration mainly depends upon the fiew centimeter of top soil of surface. Infiltration is an indicator of the soil's ability to allow water movement into and through the soil profile. The infiltration rate is of prime importance to the irrigation engineers as it influences the application rate of irrigation.[1]. It is difficult to design an irrigation system without proper knowledge of infiltration characteristics of soil [8] In dry-land agricultural infiltration characteristics will also be required for proper water management. Accurate determination of infiltration rates is important for reliable prediction of surface runoff [3]. This is useful for improvement of hydrological risk. The infiltration capacity of soil influences the occurrence of surface flow [9]. water content, field density, suction head, temperature, humidity and rainfall intensity also plays an important role in influencing the infiltration rate Infiltration is the term applied to the process of water seepage into the soil. The rate of infiltration determines the time at which water moves into the soil surface. It separates water into two major hydrologic components - surface runoff and subsurface recharge. The estimation of runoff risk has assumed an increased importance because of concerns about the associated pollution hazards. Correct resolve of infiltration rates is necessary for consistent prediction of surface runoff. As environmental impact assessments are concerned with long-term effects, it is necessary that the infiltration data on which they are based should be reasonably stable over decades. For scheduling purposes it is essential to identify the constancy of infiltration data for the infiltration capacity of individual soils is adequate to cope with the estimated hydrologic loads. In India also, very few studies have been reported that focused on infiltration based rainfall simulator experiment [10,11,12,13] have measured run-off and sediment yield over a period of 2–3 years from micro-watersheds in Kumaun Himalaya under the natural rainfall environment but studies based on simulated rainfall are very uncommon in the country. A few studies had been carried out by [14,15,16,17] for estimating the infiltration rates in different basins in different parts of India using double ring infiltrometers.

From the present study it was to assess the infiltration rate for NIT Kurukshetra campus soil. Ten Different locations was selected in the study area in order to examine the infiltration rate of locally available soil using Mini Disc infiltrometer.

2. STUDY AREA

The study area was considered in this study is campus of NIT Kurukshetra, located in Thaneshar subdivision of District Kurukshetra, State Haryana. It is located on the latitude **29.9491 N** and longitude **76.8173 E**. Ten different locations are selected within the campus to measure the infiltration and hydraulic conductivity of the soil.

Table 1: Ten Different location in N.I.T Kurukshetra

Sr. No.	Location	Latitude	Longitude
1.	Dronacharya Bhawan	29.947256°	76.820229°
2.	Eklavya Bhawan	29.94998°	76.824058°
3.	Chakwarti Bhawan	29.948930°	76.817658°
4.	Bhisam Bhawan	29.947099°	76.818633°
5.	Near Moxie	29.947151°	76.818709°
6.	Near N.I.T Chock	29.949192°	76.814594°
7.	Sports Complex	29.949730°	76.815311°
8.	Near M.B.A Block	29.945674°	76.815815°
9.	F-Type Quarters park	29.947338°	76.820205°
10.	D.B- type Quarters	29.946398°	76.811878°

3. METHODOLOGY

3.1 Determination of water content

The water content of soils is measured by standard method of oven drying. The sample collection should invovle minimum disturbence to the soil.The soil is oven dried for 24 hours at $110^{\circ} \pm 5^{\circ}$ C.

3.2 Determination of field density

The field density of soil is calculated by Core Cutter Method.

This test is done to determine the in-situ dry density of soil by core cutter method as per IS: 2720 (Part XXIX)–1975.The apparatus needed for this test are:

i) Cylindrical core cutter
ii) Steel dolley
iii) Steel rammer
iv) Balance, with an accuracy of 1g
v) Straightedge
vi) Square metal tray–300mm x 300mm x 40mm
vii) Trowel

Table 2: Values of Water Content, Field Density and Dry Density of soil at different locations

Sr. No.	Location	Water Content(%)	Field Density(g/mm^3)	Dry density(g/mm^3)
1	Dronacharya Bhawan	15.4	0.001761004	0.001526
2	Eklave Bhawan	8.86	0.001871303	0.00172
3	Chakwarti Bhawan	11.59	0.001942782	0.001741
4	Bhisam Bhawan	11.33	0.001829152	0.001643
5	Near Moxie	9.89	0.002052745	0.001868
6	Near N.I.T Chock	16.37	0.001773479	0.001524
7	Sports Complex	14.67	0.001973471	0.001721
8	Near M.B.A Block	15.56	0.001799269	0.001557
9	F-Type Quarters park	21.38	0.001719955	0.001417
10	D.B- type Quarters	10.31	0.001665681	0.00151

3.3 Determination of infiltration rate

In this study a mini disc infiltrometer (Decagon devices USA, Infiltrometer User's Manual 2014) has been used for measuring infiltration. The Mini Disk Infltrometer is ideal for field measurements; due to its compact size, the water needed to operate it can easily be carried in a personal water bottle. The upper and lower chambers of the Infltrometer are both filled with water. The bottom of the Infltrometer has a porous sintered stainless steel disk does not allow water to leak in open air. The small diameter of the disk allows for undisturbed measurements on relatively level soil surfaces.The details of the mini disc infiltrometer is depicted in Fig.1.

Fig. 1: Mini disc infiltrometer(infiltrometer User's Manual, 2014)

The instrument essentially consists of

1. Two chamber (top and bottom).
2. Total length of the infiltrometer is 32.7 cm
3. Suction control tube which is 10.2 cm long
4. Chamber barrier, which separates the two chamber
5. Water reservoir which is 21.2 cm long
6. Mariotte tube which is 28 cm long
7. Sintered stainless steel disc which is 4.5 cm in diameter and 3 mm thick.

The upper and lower chambers of the infiltrometer are both filled with water. The top chamber controls the suction head. The lower chamber contains the volume of water that infiltrates into the soil. The minidisc infiltrometer is tension infiltrometer and it can measure the hydraulic conductivity in the unsaturated medium (close to near saturation) for adjustable suction ranged from 0.5 cm to 7 cm. the details about the field expeiment and calculation processure are explained below:

1. At time zero the infiltrometer has been placed on the soil surface .
2. The volume of water that infiltrates into the ground has been recorded as the function of time
3. Based on the area of the disk the amount of the water infiltrating the soil in cm has been obtained
4. The squre root of time and infiltration in cm has been calculated

5. A graph was plotted with sqre root of time in direction and cumulative infiltartion in y direction. A polynomial equation has been fitted to the experimental data the fitting parameter of x^2 is the value of constant C_1 and that of x is the value of C_2.

$$I = C_1 t + C_2\sqrt{t}$$

Where C_1 and C_2 are the constants; I is the cumulative infiltration and T is the time.

The hydraulic conductivity of the soil is then calculated by the equation—II

$$k = \frac{C_1}{A}$$

Where C_1 is the slope of the curve plotted with the infiltration against square root of time in m/sec and A is the Van Genuchten parameter for a given soil type to the suction head and the radius of the minidisk infiltrometer. The value of A for various suction head can be computed from equation –III

$$A = \frac{11.65(n^{0.1} - 1)\exp[2.92(n - 1.9)\alpha h_{\circ}]}{(\alpha\tau_{\circ})^{0.91}}$$

where n and α are the van Genuchten parameters for the soil, ro is the disk radius, and ho is the suction at the disk surface. The Mini Disk Infiltrometer infiltrates water at a suction of -0.5 to -6 cm and has a radius of 2.25 cm. The van Genuchten parameters for the 12 texture classes were obtained from Carsel and Parrish (1988).

Van Genuchten parameters for 12 soil texture classes and A values for a 2.25 cm disk radius and suction values from 0.5 to 6 cm are shown in the table- 3

			h_o						
			-0.5	-1	-2	-3	-4	-5	-6
Texture			**A**						
Sand	0.145	2.68	2.84	2.40	1.73	1.24	0.89	0.64	0.46
Loamy Sand	0.124	2.28	2.99	2.79	2.43	2.12	1.84	1.61	1.40
Sandy Loam	0.075	1.89	3.88	3.89	3.91	3.93	3.95	3.98	4.00
Loam	0.036	1.56	5.46	5.72	6.27	6.87	7.53	8.25	9.05
Silt	0.016	1.37	7.92	8.18	8.71	9.29	9.90	10.55	11.24
Silt Loam	0.020	1.41	7.10	7.37	7.93	8.53	9.19	9.89	10.64
Sandy Clay Loam	0.059	1.48	3.21	3.52	4.24	5.11	6.15	7.41	8.92
Clay Loam	0.019	1.31	5.86	6.11	6.64	7.23	7.86	8.55	9.30
Silty Clay Loam	0.010	1.23	7.89	8.09	8.51	8.95	9.41	9.90	10.41
Sandy Clay	0.027	1.23	3.34	3.57	4.09	4.68	5.36	6.14	7.04
Silty Clay	0.005	1.09	6.08	6.17	6.36	6.56	6.76	6.97	7.18
Clay	0.008	1.09	4.00	4.10	4.30	4.51	4.74	4.98	5.22

4. RESULT AND DISCUSSIONS

The experiments were conducted by using mini disc infiltrometer throughout the year. The methodology eplained is used for determinig the infilration parameter. The upper and lower chambers of the infiltrometer were both filled with water. By controlling the suction head, the volume of water that infiltrates into the soil has been measured. The square root of time and infiltration in cm has been calculated using the methodology (Decagon devices USA, infiltrometer User's manual, 2014). The graph was plotted with square root of time in x- direction and cumulative infiltration in y-direction.

The Fig. of cumulative infiltration vs. Square root of time for different locations is given below:

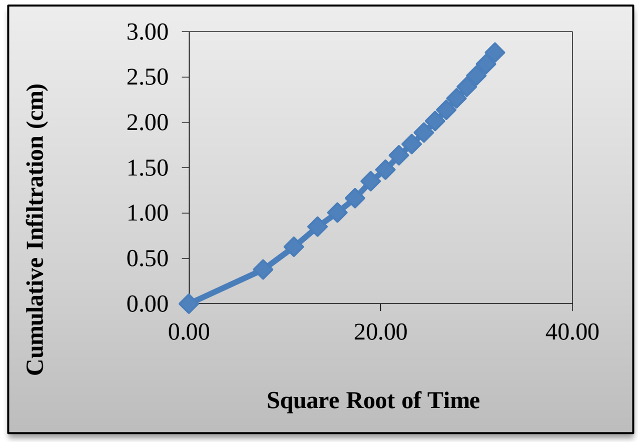

Fig. 2: Cumulative infiltration vs. Square root of time for Dronacharya Bhawan.

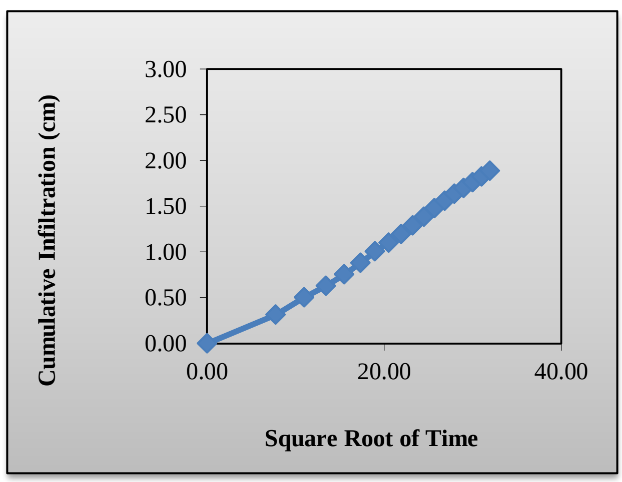

Fig. 3: Cumulative infiltration vs. Square root of time for Eklavya Bhawan.

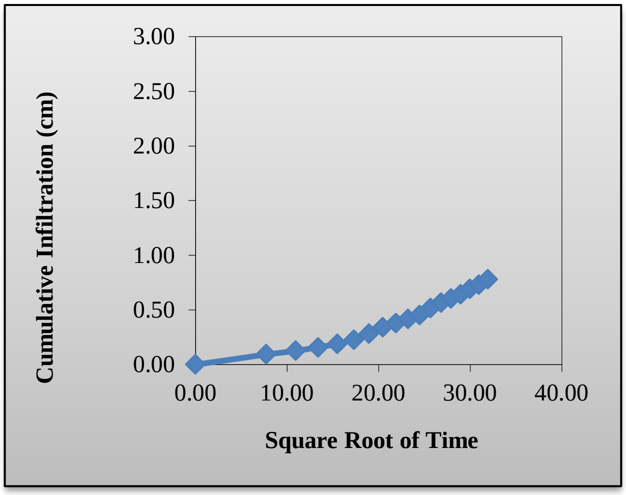

Fig. 4: Cumulative infiltration vs. Square root of time for Chakwarti Bhawan.

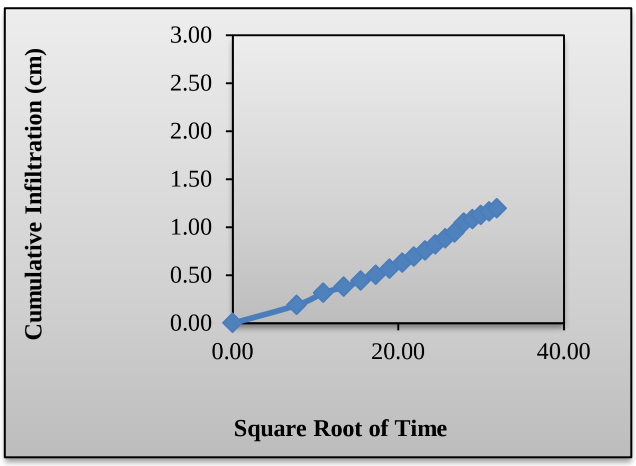

Fig. 5: Cumulative infiltration vs. Square root of time for Bhisam Bhawan.

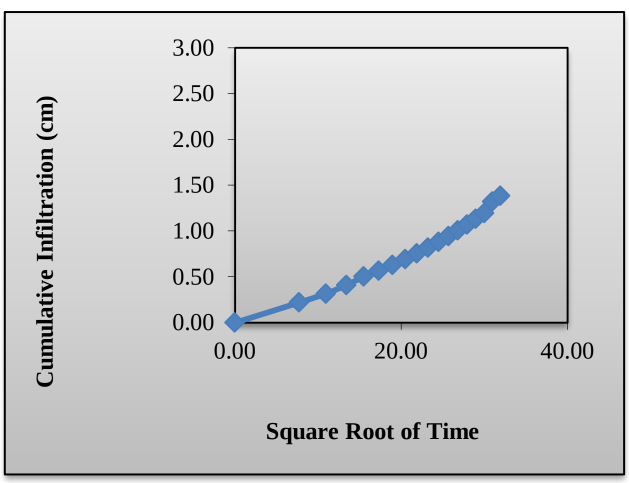

Fig. 6: Cumulative infiltration vs. Square root of time for Near Moxie.

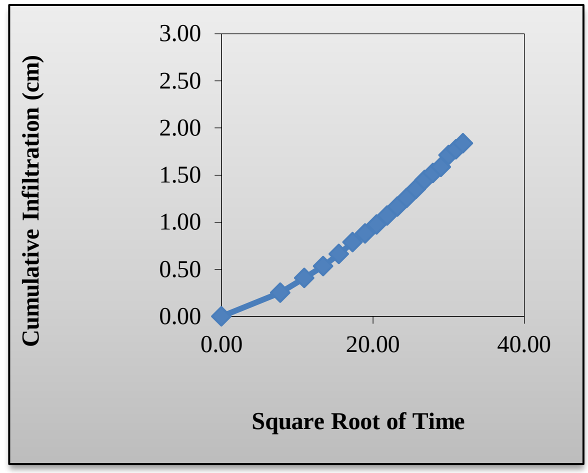

Fig. 7: Cumulative infiltration vs. Square root of time for Near N.I.T Chock.

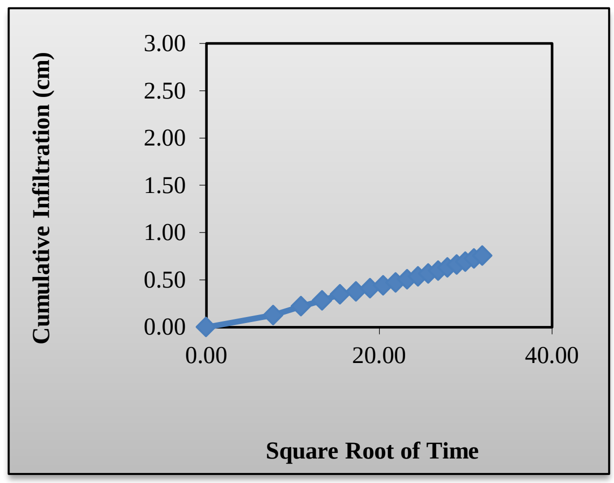

Fig. 8: Cumulative infiltration vs. Square root of time for Sports Complex.

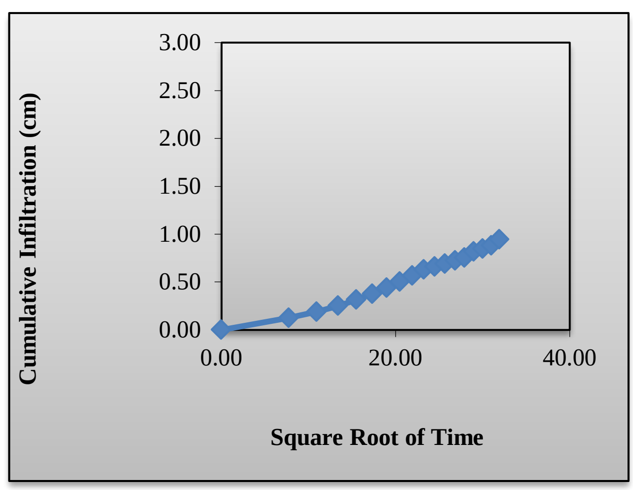

Fig. 9: Cumulative infiltration vs. Square root of time for Near M.B.A Block.

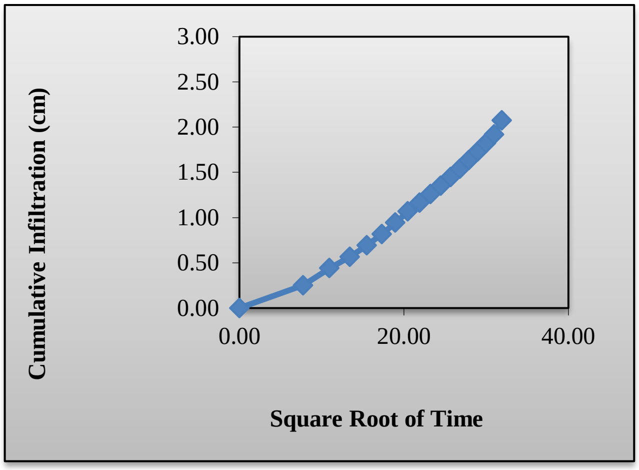

Fig. 10: Cumulative infiltration vs. Square root of time for F-Type Quarters park.

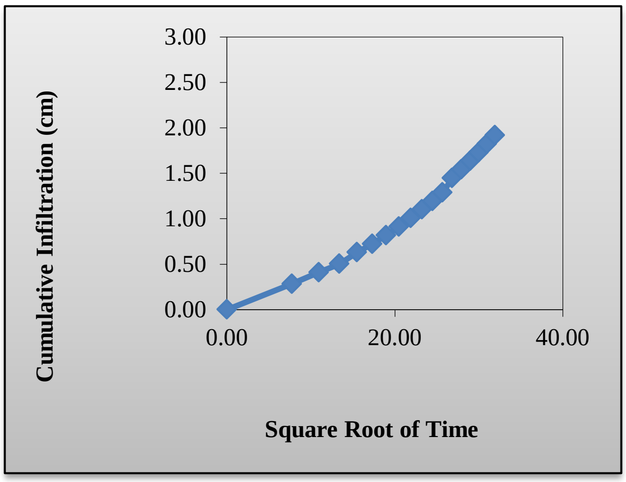

Fig. 11: Cumulative infiltration vs. Square root of time for D.B- type Quarters.

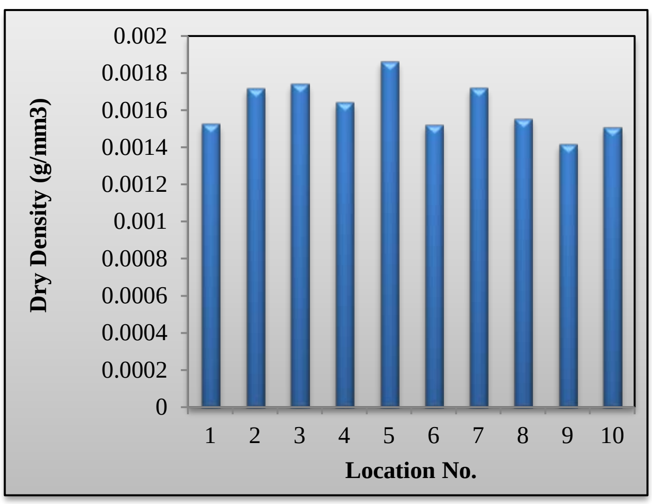

Fig. 12: Shows the value of Dry density at different locations.

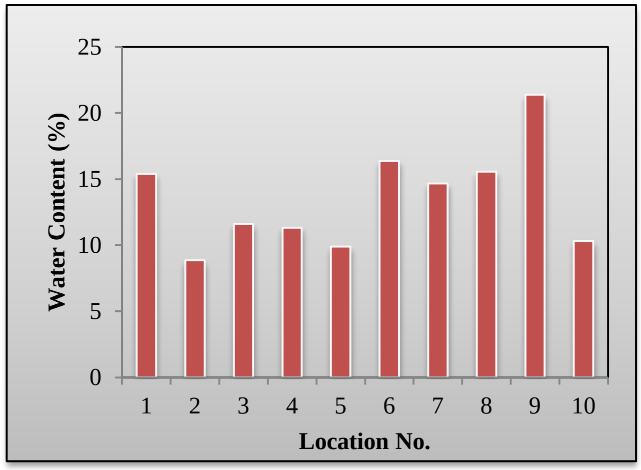

Fig. 13: Shows the value of moisture content(%) at different locations.

Table 4: Value of Hydraulic Conductivity, K(cm/s) at different locations

Sr. No.	Location	Hydraulic Conductivity, K (cm/s)
1	Dronacharya Bhawan	0.000332843 cm/s
2	Eklavya Bhawan	4.30782E-05 cm/s
3	Chakwarti Bhawan	0.000371475 cm/s
4	Bhisam Bhawan	0.00007034 cm/s
5	Near Moxie	0.00020516 cm/s
6	Near N.I.T Chock	1.99572E-06 cm/s
7	Sports Complex	0.000173727 cm/s
8	Near M.B.A Block	0.000300958 cm/s
9	F-Type Quarters park	9.95996E-07 cm/s
10	D.B- type Quarters	9.59047E-05 cm/s

The above table shows the value of hydraulic conductivity of different locations. Droacharya bhawan, Eklavya Bhawan, chakwarti bhawan,Bhisam bhawan, near Moxie, sports complex, Near M.B.A block, D.B-type Quarters have got permeable soil as the value of K is between 10^{-4} to 10^{-6}. Near N.I.T Chock and F-type Quarters park, the soil is of low permeability as the value of K is between 10^{-6} to 10^{-8}. The Fig. 11 shows the moisture content of soil at different locations and Fig.12 shows the dry density of soil at different locations. Both these parameters contribute to the hydraulic conductivity of the soil. The different locations are characterized by latitude and longitude. The soil at different locations are almost same i.e. sandy loamy. But the variation of infiltration mainly contributed by the variation in moisture content and dry density of the soil.

5. CONCLUSIONS

1. The maximum hydraulic conductivity (K=0.000371475 cm/s) is of the location 3 i.e (Chakwarti Bhawan) having moisture content of 11.59 and dry density of 0.001741 g/mm^3.

2. The minimum hydraulic conductivity (K=9.95996E-07 cm/s) is of the location 9 i.e (F-Type Quarters park) having the maximum moisture content of 21.38 and dry density of 0.001417 g/mm^3.
3. The soil type of N.I.T Kurukshetra is Sandy loam which is permeable to low permeable
4. The Water Content is inversely proportional to Infiltration.
5. Dry Density is directly proportional to infiltration.

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