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COMPARISON OF INFILTRATION RATE USING HORTON'S AND GREEN AMPT METHOD

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ABSTRACT

Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate in soil science is a measure of the rate at which a particular soil is able to absorb rainfall or irrigation. It is measured in cm per hour or millimeters per hour.The infiltration capacity is dependent on a large number of factors; some of them are characteristics of the soil, vegetative cover, condition of the soil surface, soil temperature, water content of the soil, rainfall intensity, etc. If the intensity of rainfall exceeds the infiltration rate of a given soil it results in a runoff. At a certain moment the maximum infiltration rate can be indicated by the infiltration capacity of soil. Based on the infiltration rate obtained, soil type and soil texture can be determined. From the data collected from the sites,a graph is plotted against time and infiltration rate. And based on the graph the infiltration rate is found out by using Horton's method. Depending upon the soil texture and parameters of Horton's method green ampt value is calculated for a site by using iteration method. The difference of expected value and observed value gives the chi-square value. This gives the best fitting model. The study aimed to determine constant infiltration rates. For getting best fitting model for particular soil and soil condition the results obtained from various statistical methods are of soils in different sites in Kollam by Horton's method and comparing it with the infiltration rates obtained by Green Ampt Method used.

KEYWORDS: Infiltration, Infiltration rate, Soil Texture

I. INTRODUCTION:

Infiltration is the process by which water on the ground surface enters the soil surface. Precipitation falling on the soil wets down and it starts penetrating into the soil. Water restores to the formal level the soil moisture deficiency excess moving down by the gravity force through percolation or seepage to build up the water table. The water is driven into the porous soil by force of gravity. First the water wets soil grains and then the extra water moves down due to gravitational force. The rate at which a soil absorbing the water in a given time is called infiltration rate and it depends on soil characteristics such as hydraulic conductivity, soil structure, vegetation cover.

The infiltration plays an important role in generation of runoff volume, if infiltration rate of given soil is less than intensity of rainfall then it results in either accumulation of water on soil surface or in runoff. The different soil conditions affect the soil infiltration rate. Compacted soils due to movement of agricultural machines have a low infiltration rate which is prone to runoff generation.

Infiltration will be maximum at the beginning and it decays exponentially and gets a constant value. There will be a decrease in infiltration rate day by day due to the saturation of the soil where as on the first day the infiltration rate will be more because soil will be dry in condition. Infiltration of water into the soil has important impact in the overall functioning of the variable land based activities. Two factors can greatly undermine availability of water for crops which is impervious layer ground water table.The former might be due to excess infiltration which mostly a function of soil characteristic get through the later may be largely due to the deposite of the clay that can create crust below the surface.The study of infiltration comes in many hydrological problems like runoff estimation,, soil moisture budgeting and for planning of irrigation. Infiltration has important role in hydrological cycle.

II. FACTORS AFFECTING INFILTRATION :

- Soil Texture and Structure
- Conditions at Soil Surface
- Soil-Moisture Content
- Type of Vegetative Cover
- Soil Temperature
- Human Activities on Soil Surface
- Soil Density
- Biological crusts

III. STUDY AREA :

Four sites of Kollam city of Kerala State was selected for study. The four sites are Ashramam Maidanam, Railway Station, Bishop Jerome Institute Campus, Kuthirappanthy.

IV. MEASUEMENT OF INFILTRATION RATES :

Double ring infiltrometer method was used formeasurement of infiltration rates at all the sites. In this two concentric rings were used with 25cm deep, and diameter of 30cm for inner ring and 60cm for outer ring. The rings were driven at about 15cm deep in soil by using falling weight type hammer striking on a wooden plank placed on top of ring uniformly without or undue disturbance to soil surface. Water was poured into the rings to maintain depth of 7 to 12 cm and the quantity of water was added to maintain this depth at regular time interval of 5, 10, 20, 30 min. up to getting a constant infiltration rate.
The observations for infiltration rate were carried out on inner ring with field type point gauge and stopwatch etc.

V. INFILTRATION MODELS :

The following infiltration models were assessed forfinding best fitting model to observed field infiltration rate data.

VI. HORTON'S MODEL:

Horton expressed decrease of infiltration capacity with time as an exponential decrease as,
$f = fc + (fo - fc)\, e^{-kt}$
where ,
f is infiltration capacity at any time t.
fc is final steady state infiltration capacity.
fo is initial infiltration capacity.

k Horton's constant representing rate of decrease in infiltration capacity.
t is time in hours.

VII. GREEN – AMPT MODEL:

$F(t) = Kt + \psi\Delta\theta \ln\left(1+\frac{F(t)}{\psi\Delta\theta}\right)$

where ,
K is hydraulic conductivity.
ψ is wetting front suction head.
tis time.
$\Delta\theta = (n-\theta_i)$.
n is porosity
$\theta_i$is initial moisture content

Statistical Analysis
CHI-VALUE
$\chi^2 = \frac{\sum (O_i - E_i)^2}{E_i}$

where ,
$O_i$is observed value.
$E_i$is expected value.

VIII. RESULT AND DISCUSSION :

Double ring infiltration test is done in various site such as Ashramam Maidanam, Railway Station, Kuthirappanthy , Bishop Jerome Institute Campus. Five sets of reading is taken from each site and average infiltration rate (Horton's method) is given in Table 2. One set of reading taken in BJI Campus is shown in Table 1 and corresponding graph is shown in figure 1.

Table 1 : Experimental data of infiltration rate and time at BJI Campus

Time (min)	Infiltration rate (cm/hr)
5	72
10	55
15	39
20	30
25	24
30	20
35	17
40	14
45	12
50	11
55	11
60	11

Figure 1 : Graph plotted between infiltration rate vs time at BJI Campus

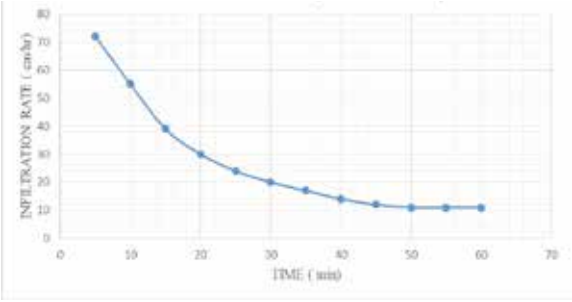

Table 2 : Comparison of infiltration rate Horton's and Green Ampt method

Location	Infiltration rate using Horton's Method (cm/hr)	Infiltration rate using Green Ampt Method (cm/hr)
Ashramam Maidanam	24.6	21.2
Railway Station	18.5	13.7
BJI Campus	7.9	11.76
Kuthirappanthy	16.5	12.8

Table 3 : Statistical Analysis

Location	Chi-square Value	Null Hypothesis
Ashramam Maidanam	0.545	Accepted
Railway Station	1.68	Accepted
BJI Campus	1.26	Accepted
Kuthirappanthi	1.06	Accepted

IX. CONCLUSION :

At Ashramam Maidanam the null hypothesis is accepted, which means both Horton's method and Green Ampt method can be adopted and also from the experimental studies, it has got sandy soil.

At BJI campus and Agricultural field at Kuthirappanthy the null hypothesis is accepted. Here the soil is sandy in nature.

At Kollam Railway Station, the null hypothesis is accepted which means that both Horton's and Green Ampts method can be adopted.

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