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Effect of Initial Moisture Content on Infiltration in an Orissa Soil

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Effect of initial moisture content on Kostiakov-Lewis type infiltration equation was studied in a soil in Orissa. The relationship between constant K, exponent, n and initial moisture content, X has been shown in a form of graph. A methematical relationship between accumulated depth of infiltration for the period of 30 minutes and moisture content has been developed.

For planning the irrigation systems, it is essential to determine the infiltration rate of water into the soils. Studies on the infiltration capacity of soil, are of great value also in predicting the rate and volume of runoff. The initial infiltration rates are of interest in estimating the lowest possible water yields under dry conditions. These parameters of infiitration capacities, in turn, affect the choice of soil conservation measures and drainage systems for the land. Since the inception of research activities in the field of irrigation, engineers and scientists have been confronted with the complicated problem of determining variable infiltration characteristics of soil. It is now an established fact that infiltration is a function of time and sufficient work has been done towards this end. Infiltration characteristics of soil is governed by different properties of the soil. As no work on intake rate of soil has been done earlier at Bhubaneswar, this work was taken up to study the effect of initial moisture content on the infiltration rate. The changing infiltration rate with initial moisture content of the soil will make it impossible to apply irrigation water efficiently because it is difficult to perform infiltration test every time the irrigation is applied. This difficulty can be overcome by relating initlal moisture content of the soil with constants of infiltration equation. In this paper, an effort has been made to relate initial moisture content of the soil with empirical constants (K, n) in Kostiakov-Lewis equation.

Hansen (1960) summerised the earlier work on infiltration and reported that the following infiltration equations are generally used :

$$Y = K t^n \quad \ldots \quad (1)$$

$$Y = Ct + K_1 \ t \quad \ldots \quad (2)$$

$$Y = C_1 t + K_2 (l\text{-}e^{-rt}) \quad \ldots \quad (3)$$

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where, Y = accumulated depth (cm) of infiltration in time i,

t = elapsed time (min)

and C, C_1, K, K_1, K_2, r and n = Characteristic constants.

Kostiakov (1932) was the first to propose equation (I). Later in 1937, the same equation was proposed independently by Lewis. The equation gives sufficient by accurate results for short periods of time and has been used extensively by others because it renders itself for easy manipulation in mathematical analysis.

Horton (1940) suggested the equation 2. This has been used by Lewis and Milne (1838) in their derivation for water advance in borders. However, complexity of this equation made it less practical.

Philip (1954) proposed equation 3 as a result of his detailed mathematical and physical analysis of infiltration into homogeneous soils. The first term on right hand side of this equation represents the contribution to infiltration by capillary potential, while the second term consists, essentially of that arising from gravity. This equation holds promise for infiltration tests carried out for longer periods.

MATERIAL AND METHODS

Experiments on soil infiltration were conducted in field. The soil was sandy clay consisting of 64per cent sand, 14per cent silt and 22 per cent clay. An inner cylinder, from which the infiltration measurements were taken, was 30 cm in diameter. The outer cylinder which was used to form the buffer pond was 60 cm in diameter. The cylinders were installed about 15 cm deep in the soil. Care was taken to keep the installation depth of the cylinders the same in all the experiments. Two point gauges, one at the centre of the inner cylinder and another at the side of the outer cylinder, were fixed to maintain constant water depth of nearly eight cm which is approximately equal to the expected level during irrigation opplication, Water was added to the inner cyclinder from a graduated jar. All the experiments were replicated thrice and the average values were considered for analysis.

RESULTS AND DISCUSSION

The amounts of infiltration during successive time intervals at different soil moisture contents are shown in Table I

From the above Table it is seen that as the moisture content of the soil increases the accumulated depth of infiltration decreases. The soil layer wet by infiltration could be divided into three parts, the transmission zone, the wetting one and the wet front. In moist soil the potential gradient at the wet front is lower than that of dry soil. £his lowered potential gradient dominates the infiltration process in the moist soil and reduces the rate of entry. The

TABLE - I Accumulated Depth of Infiltration at Different Moisture Contents

Elapsed time (minutes)	Accumulated depth of infiltration (cm)				
	Initial soil moisture content per cent				
	2.2	3.67	6.62	8.35	8.57
5	0.509	0.339	0.339	0.099	0.028
10	0.707	0.509	0.339	0.268	0.070
15	0.835	0.622	0.481	0.325	0.099
20	1.019	0.622	0.523	0.368	0.184
25	1.089	0.679	0.608	0.396	0.212
30	1.160	0.697	0 665	0.481	0.224
35	1.217	0.750	0.743	0.580	0.268
40	1.344	0.778	0.806	0.665	0.304
45	1.429	0.849	0.850	0.736	0.346
50	1.500	0.920	0.891	0.736	0.382
55	1.599	0.976	0.934	0.764	0.424
60	1.698	1.033	0.976	0.806	0.445
70	1.840	1.146	1.118	0.920	0.502
80	2.009	1.245	1.888	1.033	0.560
90	2.123	1.415	1.259	1.132	0.601
100	2.265	1.514	1.337	1.203	0.629
110	2.377	1.613	1.450	1.259	0.778
120	2.505	1.712	1.521	1.344	0.849
130	2.625	1.840	1.613	1.415	0.905
140	2.675	1.924	1.691	1.500	0.905
150	2.788	2.038	1.776	1.585	0.905
160	2.929	2.137	1.847	1.670	0.934
170	3.000	2.236	1.924	1.740	0.962
180	3.071	2.321	2.038	1.811	0.962

reduced rate of entry in moist soils could further be explained by the fact that less water was needed to fill the pores since a greater percentage of the pores was filled than in the dry soil. Data from Toble I were analysed by the least square method and infiltration equations (Table II) were developed to know the soil parameters.

From Table II it is evident that the value of coefficient, K, decreases as the initial moisture content of the soil increases. Infiltration rate of soil is greatly governed by capillary potential of that soil. As the capillary potential increases, the infiltration rate decreases as a result the value of coefficient, K, in the infiltration equation decreases.

The data for the above relationship were analysed by least square method of curve fitting and a suitable relationship was developed which is given below in the form of an equation.

TABLE II Infiltration Equation Obtained at Different Initial Moisture Contents of Soil

Initial moisture content (%)	Infiltration equation	Correlation Coefficient, (r)
2.2	$Y = 0.2327\ t^{0.485}$	0.989
3.67	$Y = 0.1354\ t^{0.515}$	0.981
6.62	$Y = 0.1185\ t^{0.523}$	0.985
8.35	$Y = 0.0579\ t^{0.642}$	0.899
3.57	$Y = 0.0125\ t^{0.8504}$	0.915

$$Y = 1.5302 - 0.1383X \quad \ldots \quad \ldots \quad \ldots \qquad (4)$$

Where

Y = accumulated depth of infiltration (cm) for the period of 30 minutes and

X = Initial moisture content of the soil per cent.

As the correlation coefficient is 0.853 it can be said that a linear relation between accumulated depth of infiltration and soil moisture content holds good.

The present study carried out at Orissa University of Agriculture and Technology, Bhubaneswar, Orissa, showed that the coefficient, K, in Kostiakov-Lewis equation decreases with increasing initial moisture content and the variation takes place in a logarithmic curvillinear form, the index, n, increases with initial moisture content in a logarithmic curvillinear form, equations given in Table II have been developed to find out the instantaneous infiltration rate of the soil at different soil moisture contents, and accumulated depth of infiltration for the period of 30 minutes con be predicted by the equation (4) in order to know the amount of runoff from the land.

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