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Infiltration Studies in Irrigated Black Cotton Soil of Coimbatore

by

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Introduction: For efficient management of water in any region, a thorough knowledge of soil moisture movement in that region is very essential. The three methods of soil moisture movement are infiltration percolation and capillary movement. Infiltration has been defined as the downward entry of water into soil. Infiltration rates of soil are needed for run off determination and for application of irrigation water to agricultural lands. Measurement of infiltration when made in the field gives valuable information as some field conditions which affect infiltration cannot be reproduced in the laboratory.

Review of Literature: Earlier Investigations on the principles of infiltration and the factors affecting the process were many. The most recent general research on the subject of infiltration was the study by Robinson and Roliwer (1957) under field conditions and by Aronovici (1955), under laboratory conditions. Tests conducted in Ohio, U. S. A. have shown that the rates of infiltration are materially affected by depth of water on the fields during rainfall or irrigation. Tube tests of infiltration by the U. S. D. A. on 68 field sites throughout the country where soil types vary from porous gravelly silt loams to relatively impervious heavy clay soils, revealed that the rate of infiltration rate decreases with increasing clay content and increases with increasing non capillary porosity (Free *et al*, 1940). Schiff (1953) found that infiltration rates increase as driving head increases.

Material and Method: Infiltration tests were conducted using a single cylinder infiltrometer open at both ends and 45 cm long with inner diameter of 30 cm. The bottom edge of the cylinder was levelled from the outside to the inside to facilitate easy driving of the cylinder into the ground. A small plastic tube inserted through a rubber stopper fixed in the opening on the side of the cylinder at a height of 19·5 cm from the bottom edge was used as the manometer to indicate the water level inside the cylinder. The details of the infiltrometer are shown in sketch No. 1. The other apparatuses used for the tests were measuring jar, stop watch, measuring scale, water container, hammer, bucket etc.

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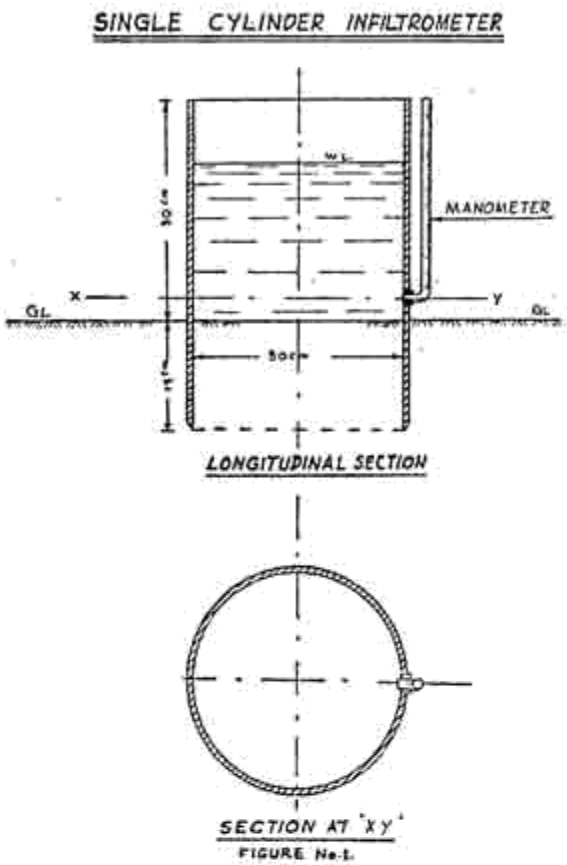

FIGURE No.1.

Tests were conducted in a black cotton soil area at the Central Farm, Agricultural College and Research Institute, Coimbatore. A levelled surface was prepared at the site of the experiment and the infiltrometer was driven into the ground gradually by giving mild blows with the hammer ensuring uniform drive on all sides. The infiltrometer was driven to a depth of 15 cm from field surface in all cases. An average head of 15 cm of water over field surface was maintained for all the tests. The time taken for the water level inside the cylinder to decrease from a height of 16 cm to 14 cm from the field surface was noted, thus the average head being 15 cm.

After the cylinder was driven to the required depth, a small quantity of straw was placed on the soil surface inside the cylinder to prevent the disturbance of top layers of soil surface while pouring water into the empty cylinder at the beginning. After pouring water to certain depth, the straw was removed and when the manometer indicated a height of 16 cm of water, stop watch was started and the time taken for the water level to recede to the reading corresponding to a head of 14 cm was noted. Immediately water was added to the cylinder to bring the head to 16 cm. The observations were continued till the rate of infiltration became constant. Six tests were conducted in different locations in the black cotton soil and the infiltration curves were obtained. The duration of the

tests varied from 2 to 4 hours. One test was conducted as a wet run after wetting the soil for 24 hours. The observations and calculations made for the Test No. 4 are given as a model.

TABLE 1. *Observation and Calculations for the Test No. 4*

S. No.	Cumulative infiltration Ic	Time taken in minutes for 2 cm drop	Cumulative time 'T'	Infiltration rate 'IR' Cm/Hr
1.	0	—	—	—
2.	2	13·20	13·20	7·786
3.	4	15·06	28·26	7·870
4.	6	16·35	44·61	7·798
5.	8	17·17	61·78	7·757
6.	10	18·13	79·91	7·711
7.	12	18·22	98·13	7·702
8.	14	18·28	116·41	7·703
9.	16	19·40	135·81	7·652
10.	18	19·37	155·18	7·654
11.	20	19·38	174·57	7·654
12.	22	19·45	194·02	7·650
13.	24	19·43	213·45	7·650
14.	26	19·40	232·85	7·652

$Ic = Ct^m$ where Ic = cumulative infiltration in cm, t = time taken in minutes and c & m are constants. The value of constants are obtained from the graph drawn for cumulative infiltration *Vs.* total time taken in minute on a log paper (Fig. 2).

Cumulative Infiltration Vs Cumulative Time in Black Cotton Soil at Coimbatore

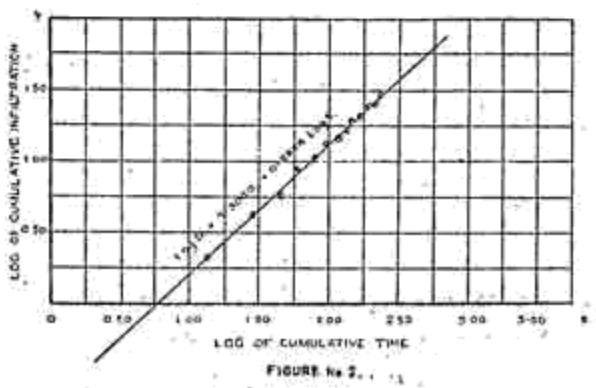

FIGURE No 2.

The value was obtained as follows :

C = 0·1995; m = 0·8888; IR = infiltration rate at any time (t); $IR = \frac{d}{dt} Ic = \frac{d}{dt} ct^m$. *ie* $IR = c \times mt^{m-1}$.

Taking the twelfth observation in the table :

t = 19·45 min; m = 0·8888; c = 0·1905; IR = 0·1995 x 0·8888 x (19·45) $^{0·8888-1}$ = 7·65 cm/hour.

Results and Discussions : The soil in which tests were conducted was sandy loam to sandy clay loam. The field capacity of the soil was found to be 25 per cent. The apparent specific gravity of the soil was 1·50. The percentages of the moisture content of the soil at the test sites just before the commencement of the tests was found to be 16·02, 15·84, 16·39, 13·62 and 14·9 for the tests numbering 1, 2, 3, 4 and 5 respectively. Test No. 6 was conducted after wetting the soil continuously for 24 hours, as a wet run.

The equations obtained for the cumulative infiltration curves are as given below :

Ic = cumulative infiltration in cm

t = cumulative time in minutes

Ic = 0·3162 t. 8125 (Test No. 1)

Ic = 0·2818 t. 8133 (Test No. 2)

Ic = 0·3162 t. 8000 (Test No. 3)

Ic = 0·1995 t. 8888 (Test No. 4)

Ic = 0·2291 t. 8500 (Test No. 5)

Ic = 0·0841 t. 9523 (Test No. 6)

In the equation for the test no. 6 (wet run) the rate of infiltration was low as the multiplying constant was very small compared to other equations. Excepting test No. 4, other equations had nearly concordant values. These equations will be useful for determining the cumulative infiltration for the soil at the above moisture condition. The infiltration rate curves are given in Fig. 3 for all the above six tests. The constant infiltration rate was found to vary from about 7·65 cm/hr to 9·20 cm/hr for the dry runs. The constant infiltration rate was found to be 2·20, 7·75, 8·32, 7·65, 7·43 and 4·18 cm/hr. for tests 1, 2, 3, 4, 5 & 6 respectively. The constant infiltration rate for the wet run was 4·18 cm/hr.

INFILTRATION RATE CURVE
Black Cotton Soil at Coimbatore

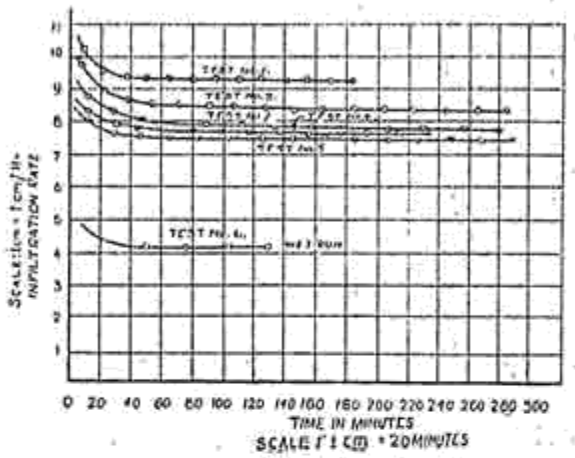

FIGURE No. 3.

The above data on infiltration for the irrigated black cotton soil areas will be of immense use in the design of irrigation methods and drainage systems.

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