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Determination and analysis of infiltration rate of soils in field using double ring infiltrometer

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Abstract
The downward moment of water from the surface into the soil is called infiltration. Infiltration of water into the soil can be determined by a simple instrument called Double ring infiltrometer. Four types of cylinders are taken for this experiment of diameter 15 cm, 30 cm, 45 cm & 60 cm and they are experimented as 15-45 cm & 30-60 cm double ring infiltrometer. The cylindrical ring infiltrometer consist of single metal cylinder. These cylinders are partially inserted into the ground and water is filled up to a margin inside the cylinder and after that the speed of penetration of water is measured with respect to the time and depth of penetration of water inside the cylinder by point gauge. To spread the water vertically after infiltration we use double ring infiltrometer. Double ring infiltrometer is better than single ring infiltrometer. In single ring infiltrometer the water will spread horizontally & vertically both, from which water will not move only towards the ground water but using double ring infiltrometer the water will penetrate in one direction that is towards the ground water without much wastage of water.

Keywords: Single ring infiltrometer, double ring infiltrometer, point gauge

Introduction
Infiltration is the process of penetration of water into the ground surface and the intensity of this process is known as infiltration rate. The infiltration rate is expressed in term of volume of water poured per ground surface per unit of time. Soil erosion, surface runoff & ground water recharge are affected by this process. At a certain moment the maximum infiltration rate can be indicated by the infiltration capacity of soil. The rate at which water is penetrating the surface of soil at any given instant is called infiltration rate the infiltration rate decrease during irrigation. The rate of decrease is rapid initially and the infiltration rate tends to approach a constant value. The nearly constant rate that develops after sometimes has elapsed from the start of irrigation is called basic infiltration rate. Accumulated infiltration, also called cumulative infiltration is the total quantity of water that enters the soil in a given time. Infiltration rate and accumulated infiltration are the two parameters commonly used in evaluating the infiltration characteristics of soil. The major factors affecting the infiltration of water into the soil are Initial moisture content, Condition of soil surface, Hydraulic conductivity of the soil profile, Texture and porosity, Degree of swelling of soil colloids, Organic matter and vegetative cover, Duration of irrigation or rainfall and viscosity of water

Material and methods
The following materials were used to determine the basic infiltration rate are briefly described as follows-

1. Infiltrometer cylinder (double ring cylinder): A double ring infiltrometer cylinder consist inner and outer cylinder having dimentions outer cylinder is 60 cm inner cylinder is 30 cm and 30 cm deep.
2. Point gauge: It consist of a sharp pointer on the tip and graduations.
3. Hammer: A millet hammer is used for compacting the cylinder in the soil to a desired depth.
4. A wooden piece: A rectangular piece of wood used to prevent the cylinder during compaction in soil.
5. A tape: A 30 cm linen tape is used for measurement at field boundary.
6. Watch: A wrist watch used as timer for measuring the time of infiltration.
7. A record note book: A record notebook, to note down the date of experiments and readings.

Measurement of infiltration: there are three methods of estimating infiltration characteristics of soil for the design of irrigation system.

1. The case of cylinder infiltrometer.
2. Measurement of subsidence of free water in a large basin
3. Estimating of accumulated infiltration from the water front advance data.

Here we used the method of use of cylinder infiltrometer for determining the basic infiltration rate. The field was carried out for the determination of basic infiltration rate of MPU, Ratibad Campus Field Bhopal. The experiment was carried out after the *Rabi* Season (i.e. after the harvesting of crop that predominates in *Rabi* Season). The use of cylinder infiltrometer is the most common methods of determining infiltration rate.

A plot was selected of about 1Ha land of agricultural field MPU Campus then making grids of required interval in the whole area at 20 meter intervals. Taking double ring cylinder infiltrometer and inserted about 10 cm deep in the soil core is taken to keep the installation depth of the cylinders the same in all experiments. This is accomplished by marking the outside of the cylinders at the 10 cm level and driving the cylinder up to the marks. The cylinders are driven into the ground by a falling weight type hammer striking on a wooden plank placed on top of the cylinder. The point gauge is set at the desired land to which water is to be added water is added to the inner cylinder from a container of known volume and a gradual jar. A stop water or the secured hand of wrist watch is used to be note the instant the addition of water begins and the time water reaches the desired level. The total quantity of water added to the inner cylinder is determine by counting the number of full containers of water and fractional volume in the jar which is added last. Care is taken to fill the container completely each time before adding water to the cylinder After the initial reading point gauge measurement are made at frequent intervals to determine the amount of water that has infiltrate during the time interval. The point gauge reading was taken before the water level than 1cm. The average depth of water maintained in cylinder is 7-12 cm which is approximately equal to the water level expected in the irrigation border or basin during irrigation. This procedure is applied in all 25 grid point and the data are tabulate on standard form. The different time intervals (5-5, 10-10, 20-20, 30-30 minutes).

The average values of accumulated infiltration y and average infiltration rates are plotted as a function of elapsed time.

The infiltration rate at any time t is obtained by given equation.

$$y=at^{\alpha}+b$$

Where

y= accumulated infiltration in time t, cm

t= elapsed time or opportunity time, minute and α, a, and b are characteristics constant.

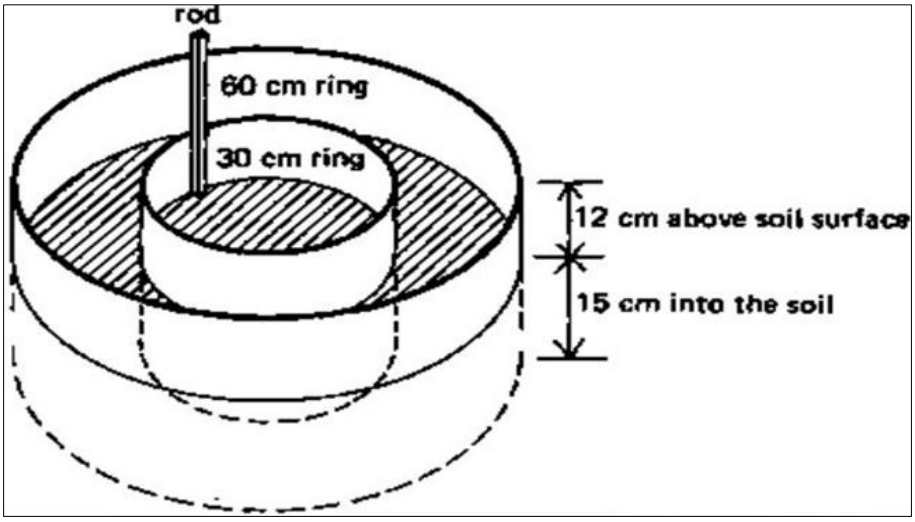

Fig 1: Line diagram of double cylinder infiltrometer

Curve fitting

The fundamental relationship between Y and t is best represented by the equation $Y = at^{\alpha} + b$, the value of a constant a, α, and b may be determined by the method of average using procedure suggested by Davis (1943). The first is to plot Y against X and choose two points (x_1, Y_1) and (X_2, Y_2) on and near the extremities of the smooth curve representing the data.

Now a point $X_3 = \sqrt{X_1 X_2}$ is chosen, Y_3 is read against X_3. The value of b is determined by using following equation:

$$b = Y_1 \times Y_2 - (Y_3)^2 / (Y_1 + Y_2 - 2Y_3)$$

ANN (Artificial neural network)

The artificial neural network can make forecasts on the premise of its past researching the yield identified with new enter information set; both set ought to be of same example. The standards in artificial neural network example were focused around immediate demonstrating of the human neuronal framework. The network might be characterized utilizing three key parts: exchange capacity, network structural engineering and taking in law.

Back Propagation calculation was the best taking in method in multilayer neural network structure. The food advance back propagation neural network (BPNN) was constantly comprised of no less than three layers: data layer, shrouded layer and yield layer. A network was required to be prepared before translating new data for the following methodology. Each one layer was comprised of neurons and every neuron was joined with the following layer through weights those were called neurons in the information layer which sent its yield as info for neurons in the concealed layer and

comparable was the association between shrouded and yield layer. Number of shrouded layer and number of neurons in the concealed layer were changed as per the issue was to be explained. The amount of info and yield neuron was same as the amount of data and yield variables.

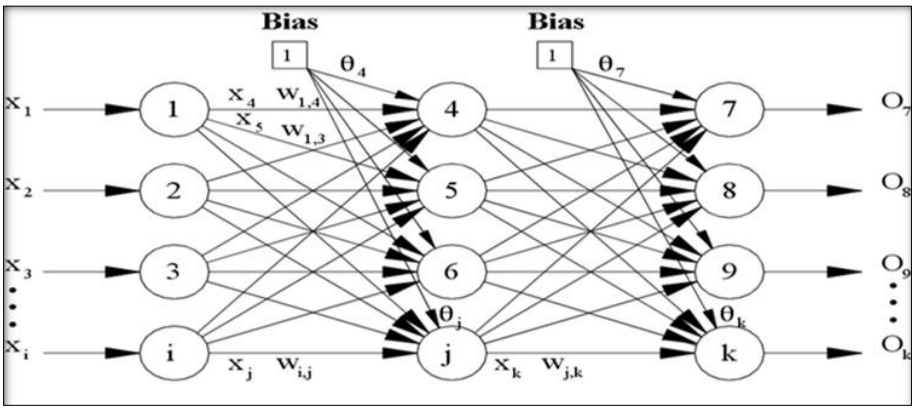

Fig 2: Back Propagation Neural Network

Components of Neuron

In segments of neuron, the greater part of the parts were depicted and were held in neural network. These segments were legitimate regardless of the fact that the neuron was utilized like information, yield and shrouded layer. A solitary neuron with fundamental components of an artificial neuron was depicted.

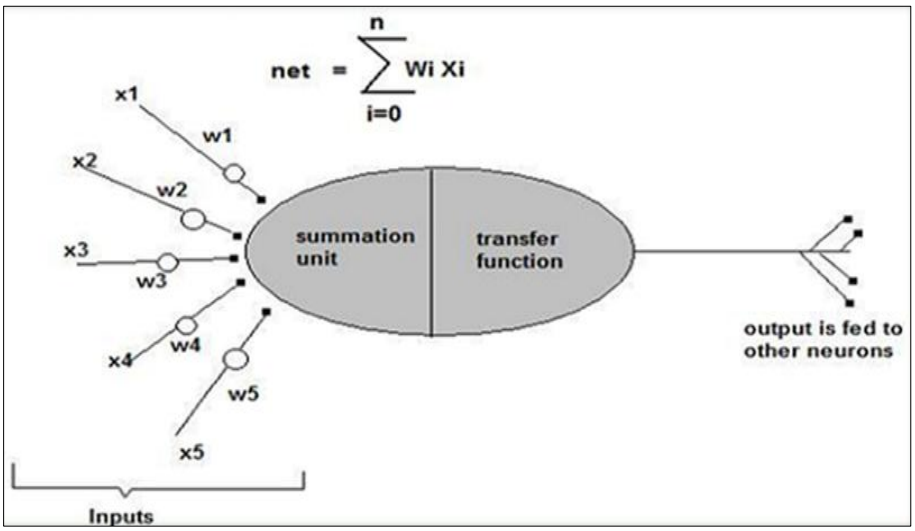

Fig 3: Basic elements Artificial Neuron

Results and Discussion

The basic infiltration rate of agricultural field at MPU Bhopal Campus field M.P. is 1.49 cm/Hr the general infiltration equation for agricultural field containing loam soil is

$Y = at^{\alpha} + b$

$Y = 0.2063\ t^{0.6094} + 0.512$

And the characteristics constants a, α and b are respectively 0.2063, 0.6094 and 0.512.

The measurements were taken in MPU field and water was spread for plants in regular interval. So, the infiltration to the soil got constant after a short time interval due to saturation of the soil. The infiltration rate and incremental infiltration rate values are approximately equal, which shows the rate of infiltration is equal in both of the methods applied. The natural soil had a high infiltration rate compared to the other fields due to the deep cracks in the soil and the low initial water content.

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