Movement of soil water- Infiltration, percolation, permeability – Drainage - Methods of determination of soil moisture –

Soil Water Movement

i) Saturated Flow

ii) Unsaturated Flow

iii) Water Vapour Movement

Saturated flow: This occurs when the soil pores are completely filled with water. This water moves at water potentials larger than – 33 kPa. Saturated flow is water flow caused by gravity's pull. It begins with *infiltration*, which is water movement into soil when rain or irrigation water is on the soil surface. When the soil profile is wetted, the movement of more water flowing through the wetted soil is termed percolation.

Hydraulic conductivity can be expressed mathematically as

$$V = kf$$

Where,

V = Total volume of water moved per unit time

f = Water moving force

k = Hydraulic conductivity of soil

Factors affecting movement of water

1. Texture, 2.Structure, 3.Amount of organic matter, 4.Depth of soil to hard pan, 5.Amount of water in the soil, 6.temperature and 7. Pressure

Vertical water flow

The vertical water flow rate through soil is given by *Darcy's law*. The law states that the rate of flow of liquid or flux through a porous medium is proportional to the hydraulic gradient in the direction of floe of the liquid.

(dw) At

$$QW = - k (dw) At / Ds$$

Where,

QW = Quantity of water in cm^{-1}

k = rate constant (cm/s)

dw = Water height (head), cm

A = Soil area ($cm^{2)}$)

t = Time

ds = Soil depth (cm)

(ii) Unsaturated Flow

It is flow of water held with water potentials lower than- 1/3 bar. Water will move toward the region of lower potential (towards the greater "pulling" force). In a uniform soil this means that water moves from wetter to drier areas. The water movement may be in any direction .The rate of flow is greater as the water potential gradient (the difference in potential between wet and dry) increases and as the size of water filled pores also increases. The two forces responsible for this movement are the attraction of soil solids for water (adhesion) and capillarity. Under field conditions this movement occurs when the soil macropores (non-capillary) pores with filled with air and the micropores (capillary) pores with water and partly with air.

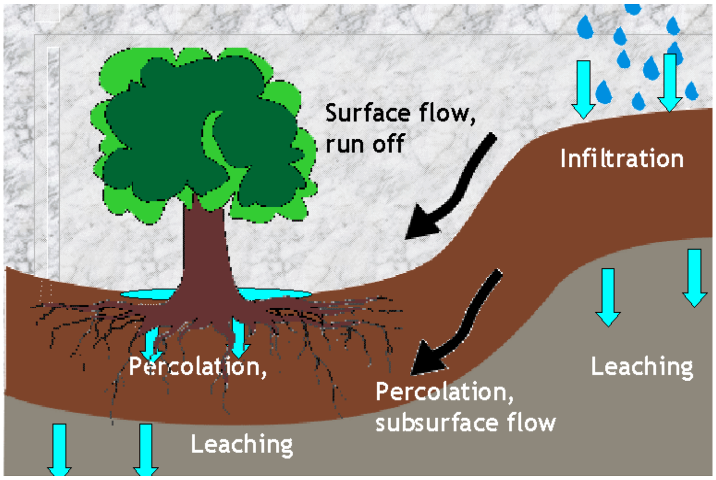
Factors Affecting the Unsaturated Flow

Unsaturated flow is also affected in a similar way to that of saturated flow. Amount of moisture in the soil affects the unsaturated flow. The higher the percentage of water in the moist soil, the greater is the suction gradient and the more rapid is the delivery.

(iii) Water Vapour Movement

The movement of water vapour from soils takes place in two ways: (a) Internal movement—the change from the liquid to the vapour state takes place within the soil, that is, in the soil pores and (b) External movement—the phenomenon occurs at the land surface and the resulting vapour is lost to the atmosphere by diffusion and convection.

The movement of water vapour through the diffusion mechanism taken place from one area to other soil area depending on the vapour pressure gradient (moving force).This gradient is simply the difference in vapour pressure of two points a unit distance apart. The greater this difference, the more rapid the diffusion and the greater is the transfer of water vapour during a unit period.



Soil conditions affecting water vapour movement:

There are mainly two soil conditions that affect the water vapour movement namely moisture regimes and thermal regimes. In addition to these, the various other factors which influence the moisture and thermal regimes of the soil like organic matter, vegetative cover, soil colour etc. also affect the movement of water vapour. The movement takes place from moist soil having high vapour pressure to a dry soil (low vapour pressure). Similarly the movement takes place from warmer soil regions to cooler soil region.In dry soils some water movement takes place in the vapour form and such vapour movement has some practical implications in supplying water to drought resistant plants.

Entry of Water into Soil

Infiltration: Infiltration refers to the downward entry or movement of water into the soil surface

- It is a surface characteristic and hence primarily influenced by the condition of the surface soil.
- Soil surface with vegetative cover has more infiltration rate than bare soil
- Warm soils absorb more water than colder ones
- Coarse surface texture, granular structure and high organic matter content in surface soil, all help to increase infiltration
- Infiltration rate is comparatively lower in wet soils than dry soils

Factors affecting infiltration

i. Clay minerals
ii. Soil Texture
iii. Soil structure
iv. Moisture content
v. Vegetative cover
vi. Topography

Percolation: The movement of water through a column of soil is called percolation. It is important for two reasons.

i) This is the only source of recharge of ground water which can be used through wells for irrigation

ii) Percolating waters carry plant nutrients down and often out of reach of plant roots (leaching)

- In dry region it is negligible and under high rainfall it is high

- Sandy soils have greater percolation than clayey soil
- Vegetation and high water table reduce the percolation loss

Permeability: It indicates the relative ease of movement of water with in the soil. The characteristics that determine how fast air and water move through the soil is known as permeability. The term hydraulic conductivity is also used which refers to the readiness with which a soil transmits fluids through it

Drainage

The frequency and duration of periods when the soil is free from saturation with water. It controls the soil cum water relationship and the supply of nutrients to the plants.

Drainage class

Very poorly drained

Poorly drained

Imperfect

Moderately well

Well

Somewhat excessive

Excessive

Hysterisis

The moisture content at different tensions during wetting of soil varies from the moisture content at same tensions during drying. This effect is called as hysterisis. This is due to the presence of capillary and non capillary pores. The moisture content is always low during sorption and high during desorption. Hystersis phenomenon exists in soil minerals as a consequence of shrinking and swelling. Shrinking and swelling affect pore size on a microbasis as well as on the basis of overall bulk density. So, hystersis phenomenon occurs due to factors like shape and size of soil pores and their interconnection with each other pore configuration, nature of soil colloids bulk density of soil and entrapped air. The most important factor affecting hystersis is the entrapment of air in the soil under rewetting condition. This clogs some pores and prevent effective contact between others.

Methods of determination of soil moisture

Two general types of measurements relating to soil water are ordinarily used

i) By some methods the moisture content is measured directly or indirectly

ii) Techniques are used to determine the soil moisture potential (tension or suction)

Measuring soil moisture content in laboratory

1. Gravimetric method: This consists of obtaining a moist sample, drying it in an oven at 105°C until it losses no more weight and then determining the percentage of moisture. The gravimetric method is time consuming and involves laborious processes of sampling, weighing and drying in laboratory.

2. Electrical conductivity method: This method is based upon the changes in electrical conductivity with changes in soil moisture. Gypsum blocks inside of with two electrodes at a definite distance are apart used in this method. These blocks require previous calibration for uniformity. The blocks are buried in the soil at desired depths and the conductivity across the electrodes measured with a modified Wheatstone bridge. These electrical measurements are affected by salt concentration in the soil solution and are not very helpful in soils with high salt contents.

Measuring soil moisture potential insitu (field)

Suction method or equilibrium tension method: Field tensiometers measure the tension with which water is held in the soils. They are used in determining the need for irrigation. The tensiometer is a porous cup attached to a glass tube, which is connected to a mercury monometer. The tube and cup are filled with water and cup inserted in the soil. The water flows through the porous cup into the soil until equilibrium is established. These tension readings in monometer, expressed in terms of cm or atmosphere, measures the tension or suction of the soil.

If the soil is dry, water moves through the porous cup, setting up a negative tension (or greater is the suction). The tensiometers are more useful in sandy soils than in fine textured soils. Once the air gets entrapped in the tensiometer, the reliability of readings is questionable.

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