IES MASTER
CIVIL ENGINEERING
IRRIGATION ENGINEERING
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IRRIGATION ENGINEERING

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Weightage :-

Gate ⇒ 2 to 3 marks
ESE-prelims ⇒ 7 to 8 ques
mains ⇒ 30 to 40 marks.

CHAPTER-1 INTRODUCTION

Volume of water Supplied in time 'dt' = $Q\,dt$

$$Q\,dt = (dA)y + f \times A \times dt$$

$$(dt)(Q - Af) = y \times dA$$

$$dt = \frac{y \times dA}{Q - Af} \Rightarrow t = -\frac{y}{f} \ln(Q - Af) + C$$

at $t = 0$, $A = 0$

$$0 = -\frac{y}{f} \ln(Q) + C \Rightarrow C = \frac{y}{f} \ln Q$$

$$t = \frac{y}{f} \ln\left(\frac{Q}{Q - Af}\right)$$ **

Max. area that can be irrigated
at $t \to \infty$, $A \to A_{max} = \frac{Q}{f}$

$$A_{max} = \frac{Q}{f}$$ *

$$t = 2.303\left(\frac{y}{f}\right) \log\left(\frac{Q}{Q - Af}\right)$$ ***

Ques- Determine the time required to irrigate a strip of land of 0.04 hectares in area from a tube well with a discharge of 0.02 cumec. The infilteration capacity of the soil may be taken as 5cm/hr, and the average depth of flow on the field as 10 cm. Also calculate the maximum area which can be irrigated by this discharge?

Given -

$A = 0.04$ hectares $= 400\,m^2$,

$Q = 0.02\ m^3/s$

$f = 5cm/hr = \frac{5\times10^{-2}}{3600} m/s$

$y = 10\ cm = 0.1m$

$$t = 2.303\left(\frac{y}{f}\right)\log\left(\frac{Q}{Q-Af}\right)$$

$$= 2.303\left(\frac{0.1}{f}\right)\log\left(\frac{0.02}{0.02-(400\times f)}\right) = 2343\ sec.$$

$t = 39.05$ min $= 0.65$ hrs

Max area $(A_{max}) = \frac{Q}{f} = 1440\,m^2 = 0.144$ hectares.

CHAPTER-2 SOIL WATER & PLANT RELATIONSHIP

Soil Moisture - Water held in the voids of soil above the water table is called as Soil Moisture.

Water holding Capacity of Soil -
It depends on -

(i). Porosity of Soil (η) = $\frac{\text{Volume of voids}}{\text{Total volume of soil}}$

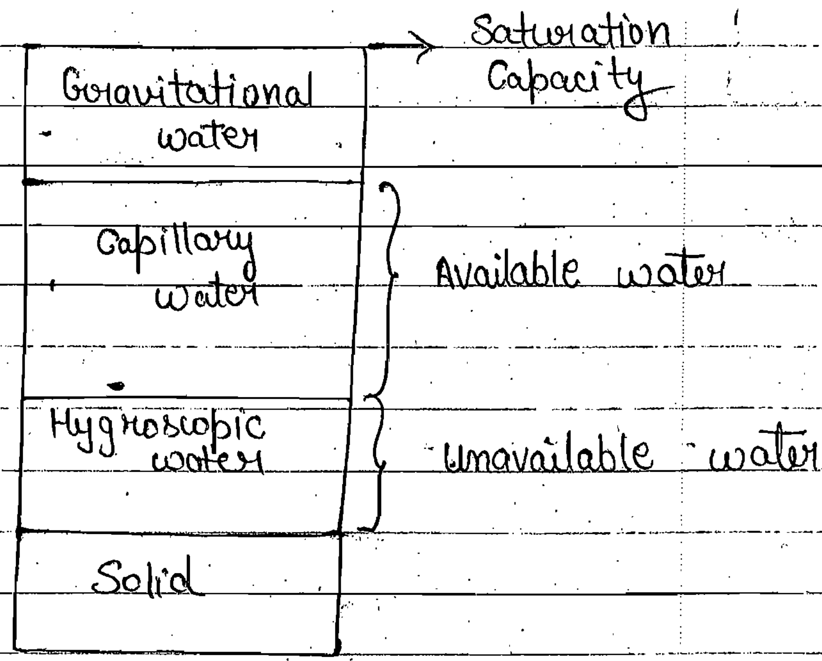
(ii) Size of voids - On the basis of size, voids can be devided into two parts.

(a) Large voids / Non capillary Voids - They do not hold water tightly hence this water is drained off under gravity.

(b) Small voids / Capillary Voids - They hold water due to Capillary action - (Surface tension) and prevents it from getting drained off under gravity.
Small voids induce better water holding capacity. Ex - Clay, while Large Voids Induced better drainage and air circulation. Ex - Sand.

NOTE: Ideal soil for Cultivation is One which has nearly equal distribution of small voids and large voids such that small voids provide greater water holding capacity and large voids provide adequate drainage and air circulation.
Ex - Loam soil (mixture of sand, silt and Clay)

Classification of Soil Water –



(i) Gravitational water – It is that water which is not held by the soil against gravity and drains out under the action of gravity. It prevents air circulation. Hence, it is harmful to the crops if present for longer duration.

(ii). Capillary water – • It is that part which is retained in the soil after gravity water has drained off and it can be absorbed by the plants roots.

- This water is held due to surface tension.

- Plant roots gradually absorb capillary water, hence it is the principle source of water for plant growth. therefore, it is called as available water.

(iii) Hygroscopic Water – • It is that water which is adsorbed (in surface) on the surface of dry soil from the atmosphere.

• It is held by considerable forces. Hence, it cannot be absorbed by plant roots, hence also called unavailable water.

Soil Moisture Tension and Soil moisture Stress –

Soil Moisture Tension (SMT) – • It is defined as force per unit area that must be exerted in order to extract water from the soil.

• SMT is usually expressed in atmospheric pressure.

$$SMT \propto \frac{1}{\text{moisture content}}$$

Soil Moisture Stress (SMS) – SMT + Osmotic pressure of soil.

If soil solution contains appreciable amount of salts then it effects the available water to the plant.

Soil Moisture Content / Constants –

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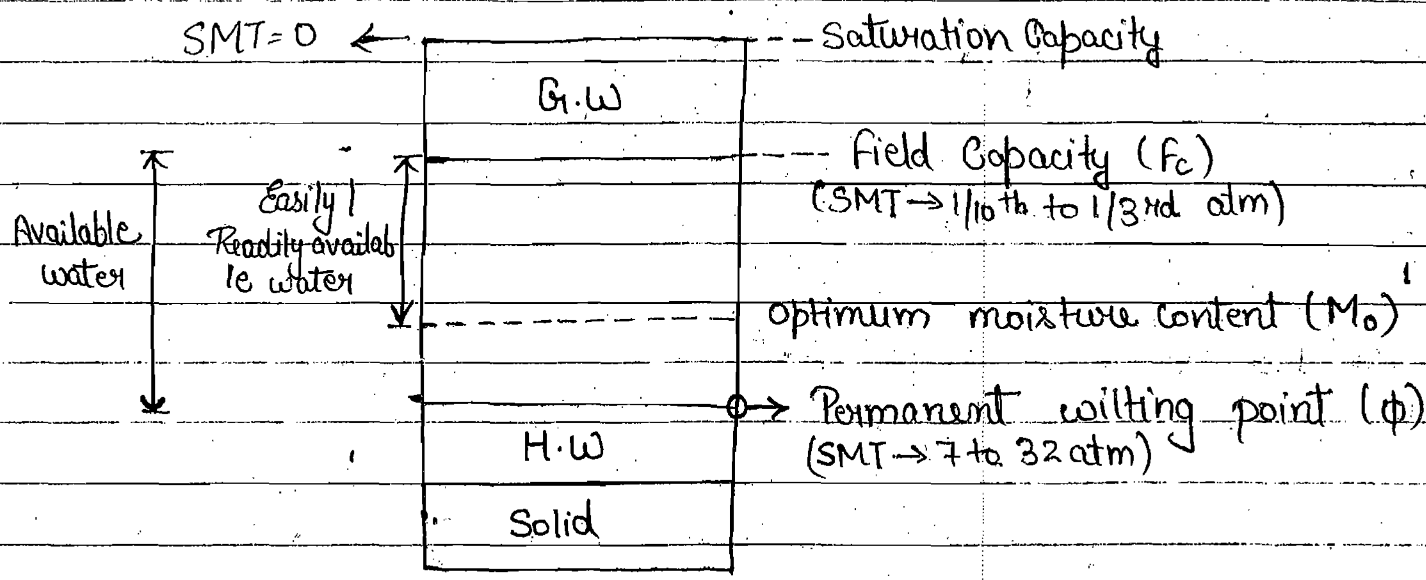

Saturation Capacity - • It is defined as the total water content of soil where all the voids are filled with water.

• This is also called as maximum water holding capacity.

Field Capacity (Fc) - Fc is the maximum amount of water that can be held by the soil against gravity. It depends on porosity and capillary tension. It includes hygroscopic and capillary water both.

$$F_c = \frac{\text{wt. of water retained in certain volume of soil}}{\text{wt. of dry soil of same volume}} \times 1$$

Permanent Wilting Point (ϕ) - It is that moisture content at which plant can no longer extract water from the soil at this moisture content plant will wilt.

ϕ is lower limit of capillary water and upper limit of hygroscopic water.

Available moisture Content - It is the difference between F_c and ϕ.

- It is also called as maximum storage capacity of soil.

Readily available moisture Content - It is that portion of available moisture which is most easily extracted by plant roots. And such a limit is called as optimum moisture content.

- In the absence of data readily available moisture Content = 75% of available moisture.

- Soil moisture content is never allowed to deplete upto ϕ for optimum growth of plant rather it is allowed to deplete only upto M_o.

Soil / Field moisture deficiency - It is the amount of water which is required to bring existing moisture content upto field capacity.