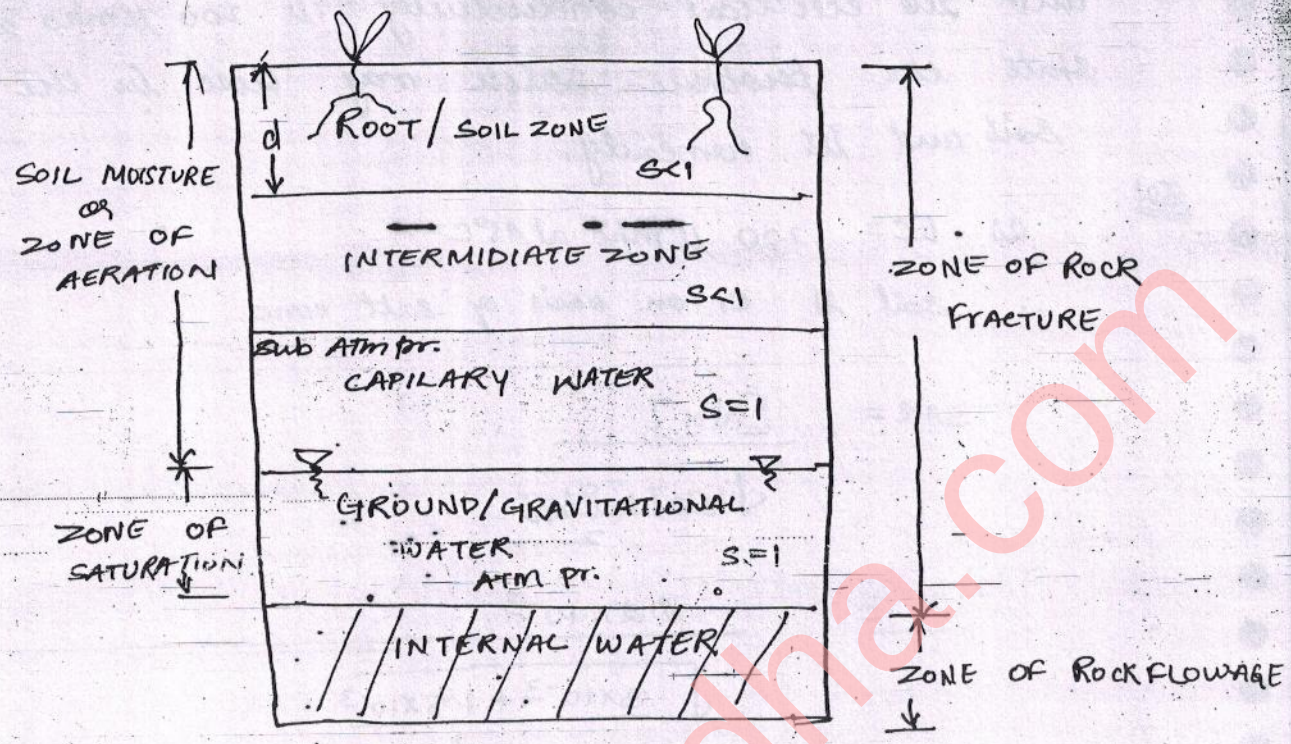
CROP WATER REQUIREMENT

V.Imp

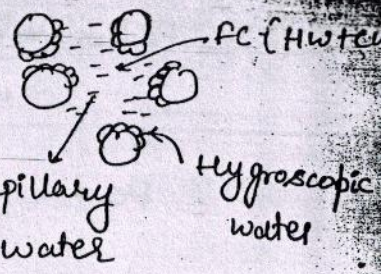


→ FIELD CAPACITY or SPECIFIC RETENTION

- Immediately after the rain or irrigation water application, when all the gravity has drained down and mixed with GW, certain amount of water is retained in the voids of soils under the effect of molecular attraction or electrical forces. (Adsorption)
- This water cannot be easily drained by gravity and is called field capacity.
- field capacity is defined as the ratio of wt. of water retained in the soil against the effect of gravity to the total wt of soil is drained.
- This field capacity can further be divided into:-
  - → capillary water
  - → Hygroscopic water.

→ Capillary Water :-

- Water attached to the soil molecules by the effect of surface tension
- Can be extracted by the plants by the capillary forces.



→ Hygroscopic Water :-

- Water which is attached to the soil molecules by the strong electrical forces and cannot be extracted by plants by capillary forces.
- It is not available for the growth of the plants.

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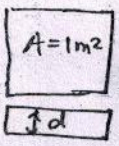
→

F.C. = $\frac{\text{wt. of water retained in soil against gravity}}{\text{wt. of soil drained.}}$

→ considering $1m^2$ → of field Area &

d → as the depth of root zone



→ wt. of soil in the root zone = Vol. of soil in root zone × density of soil

$= (1 \times d) \times \rho_s$

$= d \cdot \rho_s$.

→ wt. of water retained in soil = $f \times d \times \rho_s = fd\rho_s$

→ Vol. of water retained in soil = $\frac{fd\rho_s}{\rho_w}$

→ depth of water retained in soil = $\frac{\text{Vol.}}{\text{Area}} = \frac{fd\rho_s/\rho_w}{1}$

$= \frac{f \cdot d \cdot \rho_s}{\rho_w}$

$$FC = \frac{\text{wt. of water retained}}{\text{wt. of soil drained}}$$

$$Fc = \frac{\text{vol. of water} \times \gamma_w}{\text{Vol. of soil} \times \gamma_s}$$

$$= \frac{V_v \gamma_w}{V \cdot \gamma_s}$$

$$f = \eta \frac{\gamma_w}{\gamma_s}$$

$$\boxed{FC = \eta \frac{\gamma_w}{\gamma_s}}$$

field capacity of soil

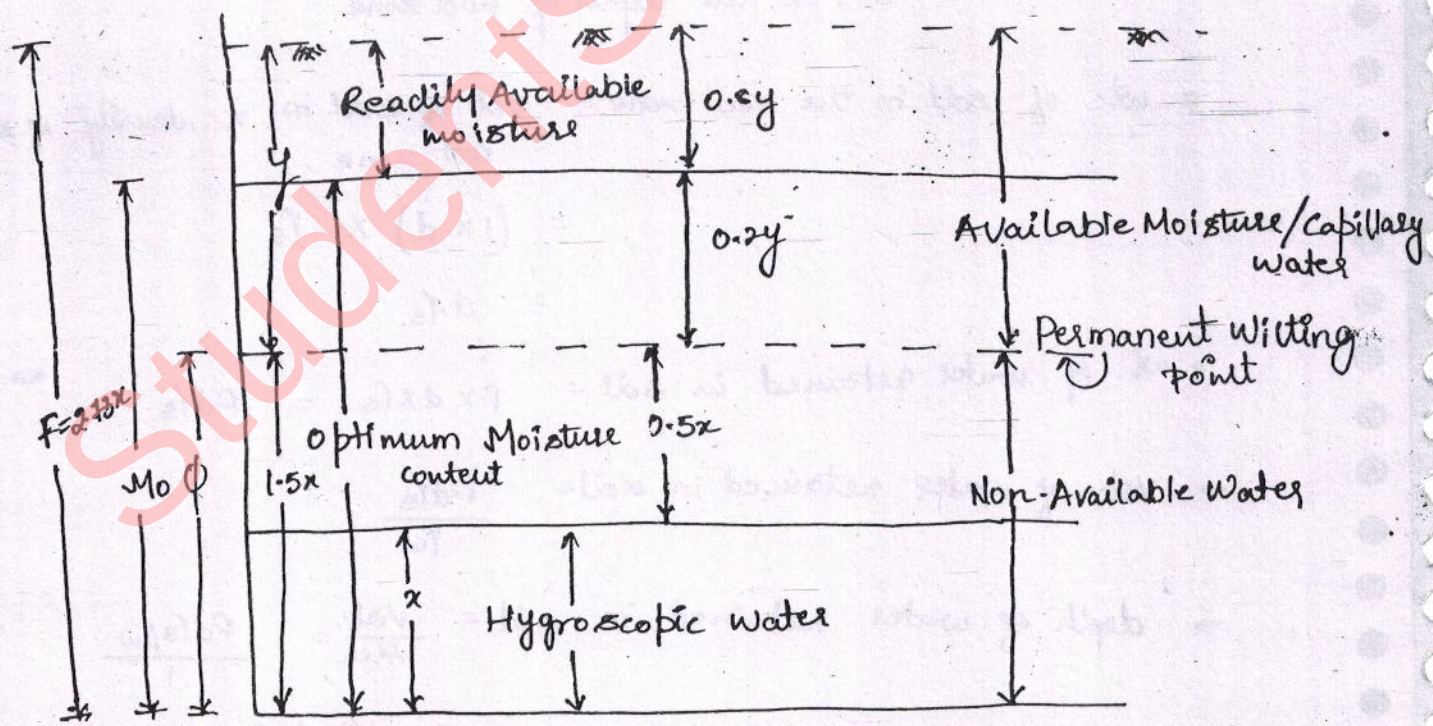
Valid only when soil is fully saturated

i.e $S = 1$

$V_w = V_v$

Depth of Root zone

depth of water in soil (Retained) $= f \times d \times \frac{\gamma_s}{\gamma_w}$



→ **PERMANENT WILTING POINT :-**

- Total water corresponding to the field capacity can not be utilized by the plants for their growth.
- Plants can extract the water from the soil only up till permanent wilting point is reached.
- PWP is that point which corresponds to the amount of water below which plants can no longer extract the water for their growth and becomes completely dry. (i.e wilt up).

⇒ Let the hygroscopic water corresponds to x.

→ Moisture content upto the PWP = $1.5x$.

→ Moisture content upto field capacity, $F = 2.73x$

→ ∴ Available moisture in the moisture, $F - \phi = 1.23x$

$= (2.73 - 1.5)x$

$= 1.23x$

This is the moisture which can be utilised by plants for their growth.

→ ∴ Depth of water corresponding to available moisture content

$$= (F - \phi) \cdot d \cdot \frac{\gamma_s}{\gamma_w}$$

→ **Readily Available Moisture :-**

- It is the portion of the available moisture which should be present for the optimum growth of plants.
- → It is approx (75 - 80%) of available moisture
- → Water is applied to field as soon as the moisture content in the soil drops to optimum moisture content level.
- → Readily available moisture = $F - M_o$

→ Readily available moisture content

= 75 to 80% available moisture content

= $(F - \phi) \times 0.8$

→ Depth of water corresponding to readily available moisture content = $(F - \phi) \cdot 0.8 \cdot \frac{d\gamma_s}{\gamma_w}$

= $(F - M_0)\, d \cdot \frac{\gamma_s}{\gamma_w}$

⇒ If (Cu) is the consumptive use.

than frequency of irrigation (f)

$$f = \frac{\text{Readily available moisture (depth)}}{Cu \text{ (in cm)}}$$

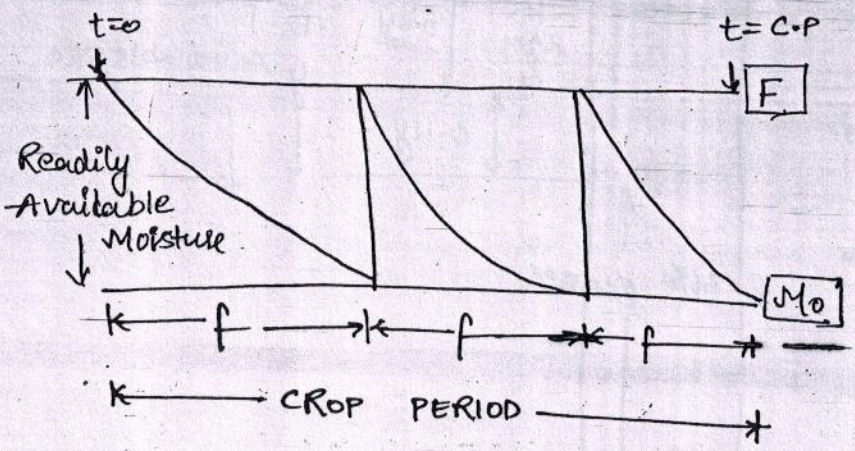
$$\boxed{f = \frac{(F - M_0) \cdot d \cdot \gamma_s}{\gamma_w} \times \left(\frac{1}{Cu}\right)}$$

→ SOIL DEFICIENCY:-

– It corresponds to the amount of water content required to bring the moisture content of soil back to its field capacity.

→ EQUIVALENT MOISTURE:-

→ It is the amount of water retained in the soil against the force of 1000 times the gravity (ie 1000g) which is acting for 30min.



Q After how many days will you supply water to the soil in order to ensure sufficient irrigation of the given crop. field capacity of soil = 28%. PWP=13%. γ_s = 1.3 gm/cm³. Affective depth of root zone 70cm. Daily consumptive use of water is 12mm. Assume any other data required.

Sol:-

f = 28% , Φ = 13%.

∴ Available M/C = 28 - 13 = 15%.

Readily available M/c = 0.8 × 15 = 12%. = f - Mo

assuming readily available M/C = 80% available M/C.

$$\text{frequency} = f = (f - M_o) \times d \cdot \frac{\gamma_s}{\gamma_w} \times \frac{1}{cu}$$

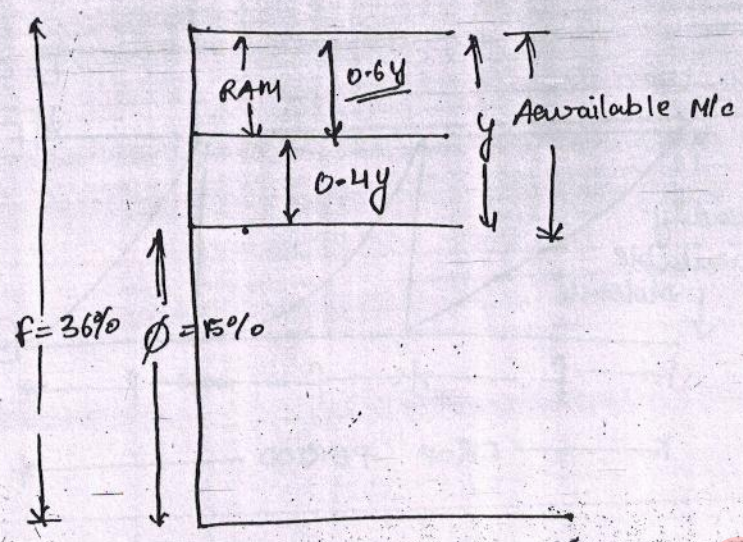
$$= \frac{12 \times 70 \times 1.3 \times 1}{100 \quad 1 \times 12 \times 10^{-1}}$$

$$= 9.1 \text{ day}$$

Q 800 m³ of water is applied to a farmers field of 0.6 hac. When the moisture content in the soil falls to 40% of the available moisture between the field capacity (=36%) and PWP (15%) of the soil crop combination. Determine the field application efficiency if the root zone depth is 60 cm. Assume the porosity to be 0.4.

Sol:-

Note: when M/C start from bottom. the 40% should be taken from BOttom of available M/C



Available M/C = 36 − 15 = 21%

RAM/C = 0.6 × 21 = 12.6%

Actual M/C = M_A = f − RAM/C = 36 − 12.6 = 23.4%.

Depth of water corresponding to readily available M/C

$= (F - M_A) \times d \times \frac{\gamma_s}{\gamma_w}$

Assuming the degree of saturation = 1

$\rightarrow F = n \frac{\gamma_w}{\gamma_s}$

$\frac{\gamma_s}{\gamma_w} = \frac{n}{F} = \frac{0.4}{0.36}$

$\gamma_s = 1.11$

$\therefore$ depth = $\frac{12.6}{100} \times 60 \times \frac{1.11}{1}$ = 84 cm.

$\therefore$ Volume of water reqd by crop = depth × Area

$= 8.4 \times 10^{-2} \times 0.6 \times 10^4$

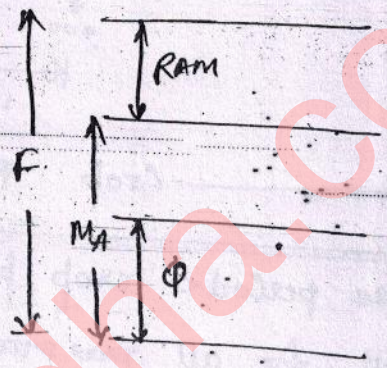
$= 504\ m^3$

$\therefore$ efficiency of water application = $\frac{504}{800}$

= 63%

Q. Determine the field capacity of the soil for the following data. Depth of root zone = 1.8m.
Existing moisture = 8%
γ_d = 1450 kg/m3.
quantity of water applied to soil = 650 m3.
Water lost due to evaporation and percolation = 10%
Area to be irrigated = 1000 m2.

Sol → Vol. of water applied
= 650 m3.
Loss = 10%.



→ Vol. of water entering into field = (1 − 0.1) × 650
= 585 m3.

→ depth of water applied = $\frac{585}{1000}$ = 0.585 m.

→ depth = $(F - M_A) \times d \times \frac{\gamma_s}{\gamma_w}$

$0.585 = (f - 0.08) \times 1.8 \times \frac{1450}{1000}$

f = 30.40%