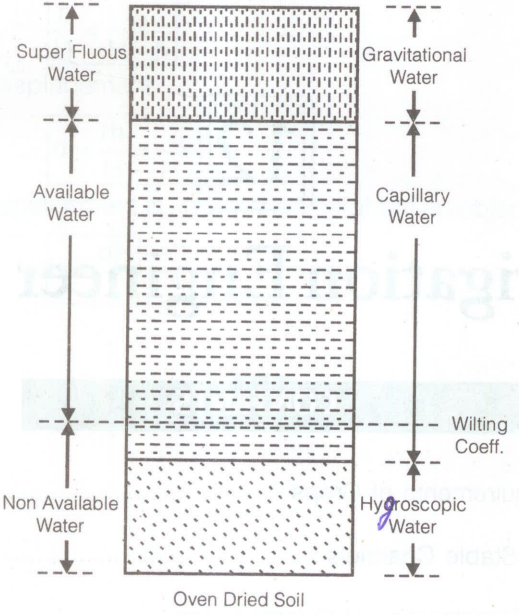
1. WATER REQUIREMENTS OF CROPS

SOIL MOISTURE

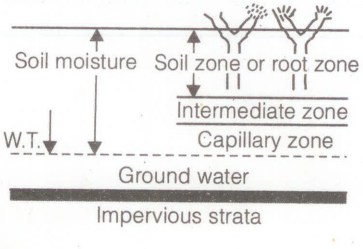
Classes and Availability of Soil Water

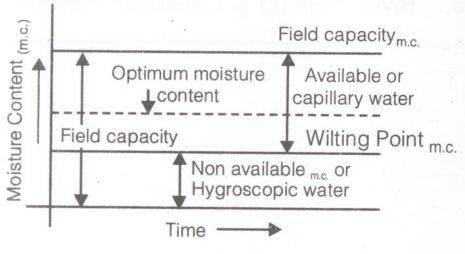
Water present in the soil may be classified under three heads:

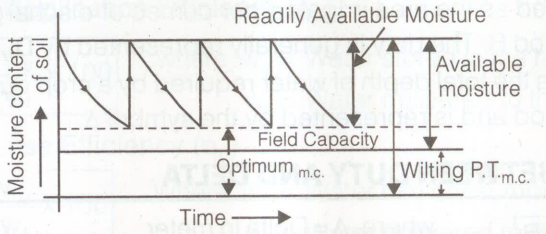
1. Hygroscopic water 2. Capillary water 3. Gravitational water



(i) $\boxed{\text{Available moisture for the plant} = F_C - \phi}$







(ii) $\boxed{\text{Readily available moisture for the plant} = F_C - M_O}$

Here, F_C = Field capacity

ϕ = Wilting point or wilting coefficients below which plant can't survive.

M_O = Readily available moisture content.

(iii) $\boxed{\text{Frequency of Irrigation} = \dfrac{\text{Available / Readily available moisture depth}}{\text{Consumptive use rate}}}$

(iv) $\boxed{F_C = \dfrac{\text{Weight of water stored in soil of unit area}}{\text{Weight of same soil of unit area}}}$

where, Weight of water stored in soil of unit area $= \gamma_w \cdot d_w \cdot 1$

Weight of same soil of unit area $= \gamma \cdot d \cdot 1$

d_w = depth of water stored in root zone.

(v) $\boxed{d_w = \dfrac{\gamma.d}{\gamma_w} \cdot F_c}$ $\gamma \rightarrow$ dry unit wt. of soil

(vi) Available moisture depth to plant

$$\boxed{d'_w = \frac{\gamma.d}{\gamma_w}(F_c - \phi)}$$

(vii) Readily available moisture depth to plant

$$\boxed{d'_w = \frac{\gamma.d}{\gamma_w}(F_c - m_o)}$$

(viii) $\boxed{F_c = n/G}$ where, G = Specific gravity and n = Porosity

DUTY AND DELTA

Duty: The duty of water is the relationship between the volume of water and the area of the crop it matures.

It is defined as the area irrigated per cumec of discharge running for base period B. The duty is generally represented by D.

Delta: It is the total depth of water required by a crop during the entire base period and is represented by the symbol Δ.

RELATION BETWEEN DUTY AND DELTA

$$\Delta = \frac{8.64B}{D}$$

where, Δ = Delta in meter
D = Duty in Ha/cumec
B = Base period in days

also $$\Delta = \frac{2B}{D}$$

where, Δ = Delta in feet
B = Base period in days
D = Duty in acre/cusec

CONSUMPTIVE USE DETERMINATION BY USE OF EQUATIONS

The following are some of the commonly used methods.

1. Penman-Method
2. Blaney-Criddle method
3. Hargreaves class A pan evaporation Method.

Blaney-Criddle Method: Blaney-Criddle equation expresses the consumptive use in terms of temperature and day time hours. If C_u is monthly consumptive use, its value is given by $C_u = k.f$ (inches)

where, k = crop factor to be determined for each crop; its value depends upon certain environmental conditions
f = monthly consumptive use factor = t × (p/100)
t = mean temperature in °F.
p = percentage of day time hours of the year, occurring during the period.

If Expressed in metric units, the above formula becomes:

$$C_u = k.\frac{p}{40}[1.8\,t + 32] = k.f$$

Where, t = temperature in °C
C_u = monthly consumptive use in cm

IRRIGATION EFFICIENCIES

(i) Water Conveyance Efficiency, (η_c)

$$\eta_c = \frac{w_f}{w_r} \times 100$$

where, w_f = Water delivered to the field.
w_r = Water delivered from the reservoir.

(ii) Water Application Efficiency (η_a)

$$\eta_a = \frac{w_s}{w_f} \times 100$$

where, w_s = Water stored in the root zone.
w_f = Water delivered to the filed.

(iii) Water use Efficiency (η_u)

$$\eta_u = \frac{w_u}{w_f} \times 100$$

Where, w_u = Water use consumptively
w_f = Water delivered to the field.

(iv) Water Storage Efficiency (η_s)

$$\eta_s = \frac{w_{s'}}{w_\eta} \times 100$$

where, $w_{s'}$ = Actual water stored in the root zone.
w_η = Water needed to store to bring the water content up to field capacity.

$$w_\eta = F_c - \text{Available moisture}$$

(v) Water Distribution Efficiency, (η_d)

$$\eta_d = \left(1 - \frac{y}{d}\right) \times 100$$

where, y = Average numerical deviation in the depth of water stored from the average depth of irrigation stored.
d = Average depth during irrigation.

(vi) Consumptive use Efficiency (η_{cu})

$$\eta_{cu} = \frac{w_{cu}}{w_d} \times 100$$

where, w_{Cu} or C_u = Water used by plant consumptively.
w_d = Net amount of water depleted from root zone.

IRRIGATION REQUIREMENTS OF CROPS

(i) Consumptive Irrigation Requirement, (CIR)

$$CIR = C_u - P_{eff}$$

where, C_u = Total consumptive use requirement.
P_{eff} = Effective rainfall.

(ii) Net Irrigation Requirement (NIR)

$$NIR = CIR + \text{Leaching requirement}$$

(iii) Field Irrigation Requirement (FIR)

$$FIR = \frac{NIR}{\eta_a}$$

(iv) Gross Irrigation Requirement (GIR)

$$GIR = \frac{FIR}{\eta_c}$$

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