Now, m.c. falls down upto 14% it means water is reduced in the soil
- If we need to raise the m.c. upto 22% (F.C.) then how much water is required ?

$$\text{Depth of irrigation water} = \frac{\gamma_d}{\gamma_w} \times d \times \left[F.C. - \text{M.C. before irrigation} \right]$$

$$= \frac{15}{9.81} \times 0.7 \times [0.22 - 0.14]$$

$$= 0.086 \text{ m}$$

$$d_w = 86 \text{ mm of water}$$

But, the efficiency is only 75% it means if we applied 100 mm water then 25% is lost due to evaporation & other

So,

If we applied 86 mm of water then it is utilized only 75% & 25% is lost from that so, we need to apply more water to fulfill the actual irrigation requirement (86 mm)

$$\text{Actual requirement of irrigation} = \frac{\text{Depth of water applied}}{\text{Efficiency}}$$

$$= \frac{86}{0.75} = 115 \text{ mm}$$

21.50
5.37

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Ex-2.16. Garg (57) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if

Field Capacity of the soil = 28 % → 27 %
Permanent wilting point = 13 % → 14 %
Dry density of soil = 1.3 gm/cc → 15 kN/m³
Effective root zone depth = 70 cm → 75 cm
Daily consumptive use of water for the given crop = 12 mm ↓ 11 mm

Assume necessary data;

Ans → 16 days

Solⁿ:- Given data;

$$F.C. = 28\% = 0.28$$
$$PWP = 13\% = 0.13$$
$$\rho_d = 1.3\ gm/cc$$
$$\rho_w = 1.0\ gm/cc \quad (Assume)$$
$$d = 70\,cm = 0.7\,m$$
$$C_u = 12\ mm/day$$

Available water = F.C. − PWP
= 28 − 13
= 15 %

Readily available moisture :- The portion of available m.c. which is readily available for plant

Assume 80% portion of the available water is readily available for plant

Therefore,

$$\text{Readily available water} = \frac{80}{100} \times 15\% \quad (\to 0.8)$$

$$RAW = 12\%$$

&

$$\text{Optimum moisture} = FC - RAW$$
$$= 28 - 12$$
$$= 16\% = 0.16$$

It means below 16% not allowed to fall down the m.c.
So, the water/irrigation filled up the moisture between 16% & 28%.

Now,

$$\text{Depth of water stored in root zone between these two limits} = \frac{\gamma_d}{\gamma_w} \times d \times [F.C. - \text{optimum m.c}]$$

$$= \frac{1.3}{1} \times 0.7 \times [0.28 - 0.16]$$

$$= 1.3 \times 0.7 \times 0.12$$

$$= 0.1092\ m$$
$$= 10.92\ cm$$
$$= 109.2\ mm$$

Now, water requirement (consumptive use) of crop is 12 mm/day

So,

- These much amount of water how many days takes to consume by the crop

$$1\text{-day} \rightarrow 12\ mm$$
$$? \quad\quad 109.2\ mm$$

$$= \frac{109.2 \times 1}{12} \frac{(mm\text{-}day)}{mm}$$

$$= 9.1\ days$$

$$\simeq 9\ days$$

Hence, after 9-days the next irrigation should be supplied to the given crop.

Ex-2.17 (Garg 158) Wheat is to be grown in a field having a field capacity equal to 27% & the permanent wilting point is 13%. Find the storage capacity in 80cm depth of the soil, if the dry unit weight of the soil is 14.72 KN/m^3. If irrigation water is to be supplied when the average soil moisture falls to 18%, find the water depth required to be supplied to the field if the field application efficiency is 80% what is the amount of water needed at the canal outlet if the water lost in the water-courses & the field channels is 15% of the outlet discharge?

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sol^n:- Given data:

$F.C. = 27\%$

$PWP = 13\%$

$d = 80cm = 0.8m$

Storage Capacity = Available water = ?

$\gamma_d = 14.72\ KN/m^3$

M.C. before irrigation = 18 %

$d_w = ?$

$\eta_{appl.} = 80\% = 0.8$

Water loss in Canals = 15 % = 0.15

- we know that

$$\text{Maximum storage Capacity} = \text{Available water} = \frac{\gamma_d}{\gamma_w} \times d \times [F.C. - PW$$

$$A_W = \frac{14.72}{9.81} \times 0.8 \times [0.27 - 0.13]$$

$$= 1.2 \times (0.14)$$

$$= 0.168\ m$$

$$= 168\ mm$$

Now, when M.C. falls up to 18 % then what amount of irrigation must be needed

$$= \frac{\gamma_d}{\gamma_w} \times d \times [F.C. - \text{M.C. before irrigat}$$

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$$= \frac{14.72}{9.81} \times 0.8 \times (0.27 - 0.18)$$

$$= 1.2 \times 0.09$$

$$= 0.108 \, m$$

$$= 108 \, mm \text{ (Net irrigation requirement)}$$

But application efficiency = 80% it means if w applied 100 mm of water then only 80 mm is used & remaining 20% is lost due to evaporation

So

Net irrigation requirement = 108 mm
(NIR)

$$\text{Field irrigation requirement} = \frac{NIR}{\eta_a}$$

$$= \frac{108}{0.8}$$

$$= 135 \, mm$$

By adding both losses = 20% + 15% = 35%
Loss of water = 0.35 × 108 = 37.80 mm
Actual water requi = 108 + 37.80 = 135 mm
Both are different because we are not considering the losses of extra water by this short-cut

Water lost on the way from head of water course to the outlet is 15% so, actual need of water @ canal head → 85% water is use

we need to loss of 35% of loss water so

37.80 × 0.35 = 13.2

$$\text{Water needed @ Canal head} = \frac{FIR}{\eta_c} = \frac{135}{0.85} = 158.8 \, mm$$

actual demand = 135 + 13.2 = 148.2

Further we need to add loss of 13.2 mm of water hence the procedure is complex/len

$1 m^2 \times 5 cm \quad \frac{5 cm^3}{25}$ 25

Ex-2.18 Garg (59)

$800 m^3$ of water is applied to a farmer rice field of 0.6 ha. When the moisture content in the soil falls to 40% of the available water between the field capacity (36%) of soil & permanent wilting point (15%) of the soil crop combination, determine the field application efficiency. The root zone depth of rice is 60 cm. Assume porosity = 0.4.

Sol^n:

Given data;

Volume of water $(V) = 800 m^3$

Area $(A) = 0.6$ ha $= 0.6 \times 10^4 m^2$

$F.C. = 36\% = 0.36$

$PWP = 15\% = 0.15$

η_a = Field application effi = ?

$d = 60 cm = 0.6 m$

$n = 0.4$

- we need to find out the available water

$$d_w = \frac{\gamma_d}{\gamma_w} \times d \times (F.C. - PWP.) \qquad (1)$$

but $\frac{\gamma_d}{\gamma_w} = ?$ (Don't assume γ_d value)

Here porosity (n) is given so, we need to find the relationship bet^n γ_d/γ_w & porosity (n)

- We already studied that

$$F.C. = \frac{\text{Wt. of water contained in } 1\,m^3 \text{ (unit volume)}}{\text{Wt. of that dry soil in } 1\,m^3} = \frac{W_w}{W_d}$$

Volume of voids (V_v) = Volume of water (V_w)

Now,

wt. of water = Unit wt. of water × Volume of void

$$\text{Unit wt} = \frac{\text{weight}}{\text{volume}}$$

So,

~~Unit wt. of water = wt.~~

$$\underset{(W_w)}{\text{wt. of water}} = \gamma_w \times V_v$$

&

$$\underset{(W_d)}{\text{wt. of dry soil}} = \gamma_d \times V$$

From eqn- (2)

$$F.C. = \frac{\gamma_w \times V_v}{\gamma_d \times V} = \frac{\gamma_w}{\gamma_d} \times \frac{V_v}{V} =$$

$$F.C. = \frac{\gamma_w}{\gamma_d} \times n \qquad (\because n = \text{porosity} = \frac{V_v}{V})$$

$$\frac{\gamma_w}{\gamma_d} = \frac{F.C.}{n}$$

$$\frac{\gamma_d}{\gamma_w} = \frac{n}{F.C.} = \frac{0.4}{0.36} = 1.11$$

From eqⁿ-(1)

$$d_w = \frac{\gamma_d}{\gamma_w} \times d \times (F.C - P.W.P.)$$

$$= 1.11 \times 0.6 \times (0.36 - 0.15)$$

$$= 0.14 \, m$$

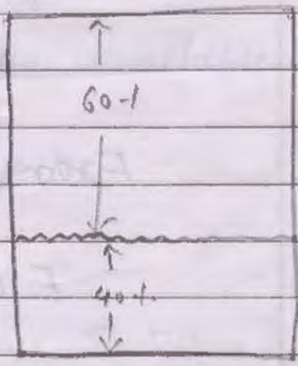
$$= 140 \, mm$$

Now, when the available water falls up to 40% then irrigation is applied (8000 m^3) & it replenish (fill up) the soil moisture deficiency of 60% (remaining)

So,

Deficiency fill up by 8000 m^3 water

$$= \frac{60}{100} \times 140$$



$$= 0.084 \, m$$

$$= 84 \, mm$$

So,

800 m^3 volume of water fill up 84mm of water depth

Volume of water used to fill up the deficiency or used by plants $= 0.084 \times 0.6 \times 10^4 \, m^3$ (0.084 → depth, 0.6×10^4 → Area)

$(V = A \cdot d)$

$V_{used} = .504\ m^3$ (Remaining water is lost due to evaporation & seepage)

&

$V_{actual} = 800\ m^3$ (As we applied)

So,

$$\text{Efficiency of field application } (\eta_a) = \frac{V_{actual}}{V_{used}} = \frac{800}{504} \times 100$$

$$= 63\ \%$$

Ex-2.21 Garg C63 — Determine the field capacity of a soil for the following data;

Depth of root zone = 1.8 m
Existing moisture content = 8 % = 0.08
Dry density of soil = 1450 Kg/m³
Quantity of water applied to soil = 650 m³
Water lost due to deep percolation & evap. = ·1
Area to be irrigated = 1000 m²

Solⁿ: Given data;

$d = 1.8\ m$
$\gamma_d = 1450\ kg/m^3$
$\gamma_w = 1.0\ gm/cc = 1000\ kg/m^3$
Volume of applied water = 650 m³
Area (A) = 1000 m²
losses (L) = 10 %

– we know that

$$d_w = \frac{\gamma_d}{\gamma_w} \times d \times (\text{F.C.} - \text{m.c. before irrigation})$$