POSTAL BOOK PACKAGE 2025

MADE EASY PUBLICATIONS

CIVIL ENGINEERING

CONVENTIONAL Practice Sets

CONTENTS

IRRIGATION ENGINEERING

1 CHAPTER Irrigation Principles, Practice and Project

Q.1 What is the classification of irrigation water having the following characteristics: Concentration of Na, Ca and Mg are 22, 3 and 1.5 milli-equivalents per litre respectively, and the electrical conductivity is 200 micro mhos per cm at 25°C ?

Solution:

$$\text{SAR} = \frac{Na^+}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}} = \frac{22}{\sqrt{\frac{3+1.5}{2}}} = \frac{22}{\sqrt{2.25}} = \frac{22}{1.5} = 14.67$$

Which lies between 10 and 18 (S_2). Also conductivity of water is 200 μ.mho/cm < 250 μ.mho/cm which is low conductivity (C_1).

∴ Given water is $C_1 - S_2$.

Q.2 What problems may arise in using the water of $C_1 - S_2$ above and what are the possible remedies of the same if the soil is fine textured?

Solution:

In fine-textured soils, the medium sodium (S2) water may create the following problems:

(i) Soil becomes less permeable.
(ii) It starts crusting when dry.
(iii) It becomes plastic and sticky when wet.
(iv) Its pH increases i.e., towards that of alkaline soil.

Gypsum ($CaSO_4$) addition, either to soil or to water is suggested to overcome sodium hazards posed by the given water.

Q.3 Determine

(i) The time required to irrigate an area of 0.05 hactare and

(ii) The maximum area that can be irrigated from a tubewell with a discharge of 0.025 cumec. The infiltration capacity of soil is given as 5 cm/hour and average depth of flow of water may be taken as 10 cm.

Solution:

Given data: Area, A = 0.05 ha = 500 m^2, Discharge, Q = 0.025 m^3/s, Infiltration rate, I = 5 cm/hour, Depth of flow, y = 10 cm

(i) Time required to irrigate the area,

$$t = \frac{2.303y}{I}\log_{10}\left(\frac{Q}{Q-IA}\right) = \frac{2.303\times 10}{5}\log_{10}\left(\frac{0.025}{0.025-\frac{5\times 10^{-2}}{3600}\times 500}\right)$$

$$= 0.652 \text{ hrs} = 39 \text{ minutes}$$

(ii) Maximum area that can be irrigated,

$$A_{max} = \frac{Q}{I} = \frac{0.025\times 3600}{5\times 10^{-2}} = 1800 \text{ m}^2 = 0.18 \text{ ha}$$

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2 CHAPTER Soil Water Plant Relationship

Q.1 Explain the term Base period and Crop period. After how many days will you order irrigation in order to ensure healthy growth of crops if:

(i) Field capacity of soil = 29%

(ii) Permanent wilting point = 11%

(iii) Density of soil = 1300 kg/m^3

(iv) Effective depth of root zone = 700 mm

(v) Daily consumptive use of water of the given crop = 12 mm

Consider moisture content must not be less than 25% of the water holding capacity between the field capacity and permanent wilting point.

Solution:

Base period: It is the time between first watering of the crop after sowing to the last watering before harvesting.

Crop period: It is the time between sowing and harvesting of the crop. Thus crop period is marginally larger than base period.

In usual usage, both crop period and base period imply the same connotation.

Numerical: Available moisture = Field capacity – Permanent wilting point

= 29 – 11 = 18%

Given moisture content must not be less than 25% of water holding capacity of soil between the field capacity and permanent wilting point.

∴ Readily available moisture = 75% of available moisture

= 0.75 × 18 = 13.5%

Thus irrigation will be required to raise the soil moisture content from 13.5% to 29%.

∴ Depth of water stored is root zone between these two limits of 13.5% and 29%

$$= \boxed{\frac{\gamma_d \cdot d}{\gamma_w}[\text{F.C.} - \text{Optimum moisture content}]}$$

$$= \frac{1300}{1000} \times 700(0.29 - 0.135)$$

$$= 0.14105 \text{ m} \simeq 0.141 \text{ m} = 141 \text{ mm}$$

Thus 141 mm of water is available for consumptive use. But daily consumptive use of water by crop = 12 mm/day

∴ 141 mm of water will be utilised in $\frac{141}{12} = 11.75$ days ≈ 11 days

∴ After 11 days, irrigation will be required.

Q.2 Estimate the depth and frequency of irrigation required for a certain crop for the following data:
Root zone depth = 90 cm
Field capacity = 22%
Wilting point = 12%
Apparent specific gravity of soil = 1.5
Consumptive use = 22 mm/day
Efficiency of irrigation = 60%
Assume 50% depletion of available moisture as the indicator to begin application of irrigation water.

Solution:

Available moisture = FC – WP = 22 – 12 = 10%
Readily available moisture = 50% of available moisture = 5%
Irrigation will be done as soon as moisture content falls from 22% to 17%
Depth of irrigation water required to raise moisture content from 17% to 22%

$$= \frac{\gamma_d d}{\gamma_w}[F.C. - \text{ Optimum moisture content}]$$

$$= 1.5 \times 90\ (22\% - 17\%) = 6.75 \text{ cm}$$

∴ Water depth required in the field $= \dfrac{6.75}{0.6} = 11.25$ cm

Depth of water available to plants for evapotranspiration = 6.75 cm
Consumptive use = 22 mm = 2.2 cm/day
∴ 2.2 cm depth of water gets used up in one day
∴ Number of days required for 6.75 cm of water depth to be used up

$$= \frac{1}{2.2} \times 6.75 = 3.07 \text{ days}$$

Hence, 11.25 cm water depth will be supplies to fields at every 3 days.

Q.3 A certain crop is grown in an area of 3000 hectares which is fed by a canal system. The data pertaining to irrigation are as follows:

Field capacity of soil = 26%
Optimum moisture = 12%
Permanent wilting point = 10%
Effective depth of root zone = 80 cm
Relative density of soil = 1.4

If the frequency of irrigation is 10 days and the overall irrigation efficiency is 22%. Find (i) the daily consumptive use (ii) the water discharge (in m^3/sec) required in the canal feeding the area.

Solution:

Field capacity (F.C.) = 26%
Optimum moisture capacity (O.M.C.) = 12%
Permanent wetting point (P.W.P.) = 10%
Depth of water stored in root zone between F.C. and O.M.C.

$$= \frac{\gamma_d}{\gamma_w}[\text{F.C.} - \text{O.M.C.}]$$

$$= \frac{1.40 \times 80}{1.0}[0.26 - 0.12] = 15.68 \text{ cm}$$

Frequency of irrigation = 10 days

(i) Daily consumptive use of water $= \dfrac{15.68}{10} = 1.568$ cm

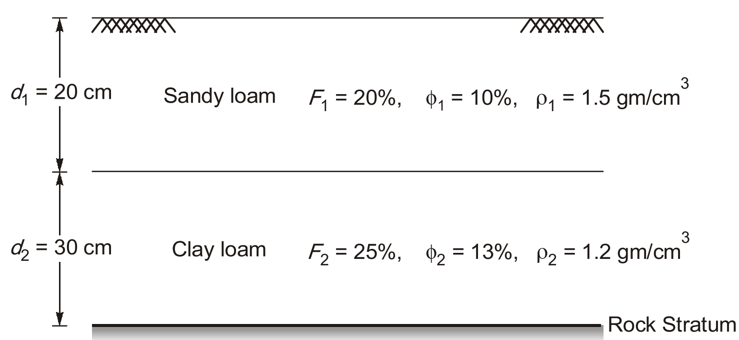
(ii) Total water required in 10 days $= \dfrac{3000 \times 10^4 \times 15.68}{100} = 4704000\ m^3$

Discharge required in canal $= \dfrac{4704000}{10 \times 24 \times 60 \times 60} =$ **5.44 cumec**

Q.4 A soil 50 cm deep over rock has two horizons, the first being a fine sandy loam 20 cm thick and the second clay loam 30 cm thick. The field capacity, wilting point and volume weight for the first horizon are 20%, 10% and 1.5 gm/cm^3 respectively. The corresponding values for the second horizon are 25%, 13% and 1.2 gm/cm^3. Determine the available moisture storage capacity of the soil profile. If consumptive use requirements of a crop in a particular season is 0.5 mm/day and the soil is initially at field capacity, how long will the crop survive without irrigation?

Solution:

The soil profile can be shown as in the figure:



Let F be the field capacity, ϕ be the wilting point, d be the depth of soil, ρ be the density of soil and γ be the unit weight of soil.

Moisture storing capacity of sandy loam is given by

$$\boxed{d_s = \frac{\gamma_1 d_1}{\gamma_w}[F_1 - \phi_1]}$$

$$= \frac{\rho_1 d_1}{\rho_w}[F_1 - \phi_1] = \frac{1.5 \times 20}{1}\left[\frac{20}{100} - \frac{10}{100}\right]$$

$= 3$ cm

Moisture storing capacity of clay loam is given by

$$\boxed{d_c = \frac{\rho_2 d_2}{\rho_w}[F_2 - \phi_2]}$$

$$= \frac{1.2 \times 30}{1}\left[\frac{25}{100} - \frac{13}{100}\right] = 4.32 \text{ cm}$$

$\therefore$ Total moisture storing capacity of the soil $= d_s + d_c = 3 + 4.32 = 7.32$ cm

It is given that consumptive use requirement of crop = 0.5 mm per day

$\therefore$ Maximum number of days in which the entire moisture storing capacity will be utilized