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Paper : Irrigation Engineering & Practice

Question 1

(a) Define "Delta" and "Duty" and write the significance of duty of crop.

Answer: **Delta:** It is the total depth of the water required by a crop during the entire period the crop is in the field and is denoted by the symbol Δ.

Duty: The term duty means the area of land that can be irrigated with unit volume of irrigation water.

Significance of duty of Crop: It helps in designing efficient canal irrigation system. Knowing the total available water at the head of the main canal and the overall duty for all the crops required to be irrigated in different seasons of the year, the area which can be irrigated can be worked out.

Inversely if we know the crop area required to be irrigated and their duties, we can work out the discharge required for designing the canal.

(b) **Solution:**

Water required after every 35 days = 10 cm = given

base period or crop period of wheat = 140 days = given

Delta for wheat = ?

Number of watering required = 140/35 = 4

Total depth of water required in 140 days = 10 × 4 = 40 cm

Δ for Wheat = 40 cm Answer.

(c) Explain the factors affecting consumptive use.

Definition :- It is the quantity of water used by the vegetation growth of a given area. It is the amount of water required by a crop for its vegetative growth to evapotranspiration and building of plant tissue plus evaporation from soils and intercepted precipitation. It is expressed in terms of depth of water. Consumptive use varies with temperature, humidity, wind speed, topography, sunlight hours, method of irrigation, moisture availability.

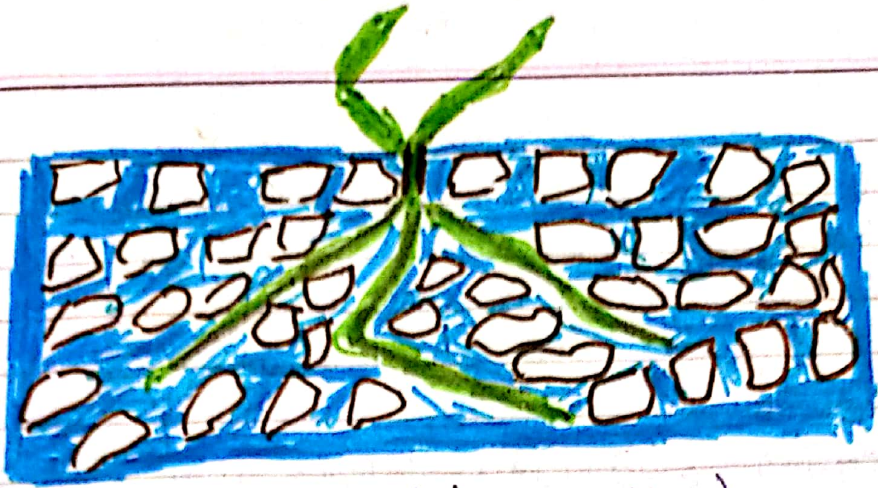
Mathematically
Consumptive use = Evapotranspiration = Evaporation + transpiration. It is expressed in terms of depth of water.

Factors affecting the consumptive use :

consumptive use of water varies with

1. Evaporation which depends on humidity
2. Mean monthly temperature
3. Growing season of crops and cropping pattern.
4. Monthly precipitation in area.
5. Wind velocity in locality
6. Soil and topography
7. Irrigation practices and method of irrigation
8. Sunlight hours.

Q2 (a) Water logging: Land is said to be water logged when its productivity is affected by high water table. High water table causes saturation of root zone. It leads ill aeration which causes the decay of nitrifying bacteria. this reduces the crop yield



(water logging and ill aeration)

Causes of water logging:-

① intensive irrigation: if max. area of land is irrigated, percolation of water takes place. This causes the rise of water table (WT).
Extensive irrigation (irrigation spread over wider regions) to be followed to avoid water logging.

② seepage of water from adjoining high lands.

③ seepage of water through canal reservoirs.

④ Impervious obstruction: water seeping below the soil moves horizontally. It may find obstruction and water table (WT) may rise.

⑤ Inadequate surface drainage

⑥ Excessive Rains

⑦ Submergence due to floods.

⑧ Irregular and flat topography.

(b) Anti-water logging measures:

① Adequate surface drainage: Quick removal of rain water by suitable surface or open drain is very important measure.

② Efficient under-drain: Providing tile drains at suitable depths below the surface of the ground to dispose of excess of subsoil water.

(3) Controlling loss of water by Seepage from the Canal: This includes lowering the F.S.L of The Canal. By lining the Canal with Suitable impervious material. By using irrigation water economically and keeping the intensity of irrigation flow.

(4) Increasing the outflow and Preventing the Inflow: This is effected by improving the flow conditions of the existing natural drainage and Providing artificial open or subsurface grid.

(5) Changing the system of irrigation: if the System of irrigation is not proper for The given area Then It is very much important to Change the irrigation system as per The conditions.

(6) Pumping out Surplus water: To Prevent the water logging of land it is very much important to pump out the excess of Surplus water from time to time to maintain The fertility and productivity of the land.

(7) Prevention of Seepage from reservoir: Reservoir should be properly maintained to Prevent the Seepage of water from The reservoir.

(8) Lining of field Channels: Proper lining of Canal and Channel Should be done. If the Channel is made proper watertight by providing lining Then Seepage loss Can be reduced upto quiet extent.

(c) Methods adopted to reclaim Saline soils:

Alkali salts (Sodium chloride, Sodium sulphate and Sodium Carbonate) are injurious to Agriculture.

$NaCl$: Least harmful

Na_2SO_4 : Medium harmful

Na_2SO_3 : Most harmful

- ★ The above salts are soluble in water.
- ★ When W.T rises up or roots are in Capillary zone, the G.W moves upwards and salts are deposited in root zone and surface of soil.

The Phenomena of Salts Coming up in solution and forming a thin crust (5-7.5cm) on the surface after evaporation of water is called Efforscence. Land effected by efforscence is called Saline soil. Salts surrounding the roots reduce the osmotic activity of Plants.

How to avoid efforscence:

- ★ By maintaining the Water table sufficiently below the roots.
- ★ Hence all the measures which were suggested for Preventing water logging had good for preventing Salinity of lands.
- ★ An efficient drainage (surface and subsurface) must be provided to lower the water table in Saline Soil.

LEACHING: in this process.

★ (1) Land is flooded with water.

(2) Alkaline Salts will be dissolved in water.

(3) Percolation to the ground water.

(4) Drained by sub surface drains.

- High Salt resistant crops like rice are grown on leached land for 1 or 2 seasons.
- Then ordinary crops like wheat or cotton are grown
- Then the land is said to have reclaimed.
- when sodium carbonate is present in the soil, gypsum is added before leaching.
- Sodium Sulphate is formed which is leached out easily.

$$Na_2CO_3 + CaSO_4 \dashrightarrow Na_2SO_4 + CaCO_3$$

Q3 (a) How does Kennedy's theory differs from Lacey's theory for the design of irrigation canal.

Answer: (1) Kennedy assumes that the eddies are produced on the bed of canal only but Lacey proposed that eddies are produced along complete wetted perimeter.

(2) Lacey states that as the shape of an irrigation canal is fixed to particular geometrical figure, it cannot achieve final regime conditions and hence may be said to achieve initial regime only. Kennedy assumes that when there is neither silting nor scouring the channel is in its regime condition.

(3) Kennedy selects Kutter's formula for designing irrigation canal. But in Kutter's formula value of "N" is fixed.

(4) Kennedy use term C.V.R (m) but he did not give any basis for calculating m. He simply states that it depends on the silt change and silt grade flowing in canal. But Lacey has introduced silt factor "f". He related "f" to mean diameter of the bed material and given basis to calculate "f". The formula is $f = 1.76\sqrt{mr}$

$$f = 1.76\sqrt{mr}$$

(5) Kennedy gives no idea for calculating longitudinal regime slope but Lacey gives a regime slope formula.

(6) Design based on Kennedy's theory can only be achieved by making trials. Lacey gave 'important wetted regime perimeter equation

$$P_w = 4.825\, Q^{1/2}$$

(6)

Q4 Write Notes on the following:

(a) Field Capacity:- The moisture condition where a soil contains the maximum amount of water that it can hold against gravity, and where further wetting will result in drainage. Following saturation, soils typically return to field capacity, when the rate of downward movement of water has substantially decreased, usually 1-3 days after rain or irrigation after the gravitational or free, water has drained away. It is typically expressed as a mass or volume fraction of soil water or as a soil moisture deficit (SMD) of zero.

(b) Permanent wilting point:- The permanent wilting point is the point when there is no water available to the plant. The permanent wilting point depends on plant variety, but it is usually around 1500 kPa (15 bars). At this stage, the soil still contains some water, but it is difficult for the roots to extract from the soil. Nearly 15 bars of tension is required to extract water by the plants. At this limit, if no additional water is supplied to the soil, most of the plants die.

The moisture content at the permanent wilting point varies with soil texture. Fine-textured soils retain higher amounts of water (~26% - 32% v/v) than the coarse textured soils (10% - 15% v/v) at the permanent wilting point.

(c) Canal head regulator: A structure which is constructed at the head of the canal to regulate flow of water is known as canal head regulator. It consists of a number of piers which divide the total width of the canal into a number of spans which are known as bays. The piers consist of number tiers on which the adjustable gates are placed. the gates are operated form the top by suitable mechanical device. A platform is provided on the top of the piers for the facility of operating the gates. Again some piers are constructed on the down stream side of the canal head to support the roadway.

(d) Under sluices: Also known as scouring sluices. The under sluices are the openings provided at the base of the weir or barrage. These openings are provided with adjustable gates. Normally, the gates are kept closed. The suspended silt goes on depositing in front of the canal head regulator.

When the silt deposition becomes appreciable the gates are opened and the deposited silt is loosened with an agitator mountaining on a boat. the muddy water flows towards the downstream through the scouring sluices. The gates then closed. But, at the period of flood, the gates are kept opened.

Q31 (b) **Design a regime channel**

V = Discharge = 30 cumecs

Diameter = 0.56mm

Lacey's Normal regime Scour depth $= 0.473\left(\frac{Q}{f}\right)^{1/3}$ → (1)

$f = 1.76\sqrt{Q}$

$= 1.76\sqrt{0.56}$

$= 1.317$ mm

Lacey's Normal Regime $= 0.473\left(\frac{Q}{f}\right)^{1/3}$

Putting the values; Q = 30 cumecs

f = 1.317 mm

$\therefore \quad = 0.473\left(\frac{30}{1.317}\right)^{1/3}$

Lacey's Normal regime = 1.326

ing Then Seepage loss ... proper watering ...
extent.