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Q.1.a)

**Ans:- Delta:-**

The depth of water in cm or inches required for the crop through out the base period is called Delta of the crop.

A crop needs a certain amount of water at fixed interval through out its base period. Depth of each watering 5cm (2") - 10cm (4")

**Duty of Water:-**

The duty of water is the relationship between the volume of water and the area of crop it matures. Volume of water is generally expressed by a unit discharge flowing

for a time of base period of the crop.

## Methamatical Relation between Duty, Delta and Base period in M.K.S System.

Let

Duty = D (hectares/cumecs)

Delta = A meter Base period = 1

= B days by definition,

One Cumec of water flowing continuously for "B" days gives a depth of water "A" over an area of "D" hectares.

Volume of water @ $1 m^3$sec in one day

$= 1 \times 24 \times 60 \times 60 = 86400 B m^3 = 86400 m^2 m$ - (i)

As 1 Hectare = $10000 m^2$

$1 m^2 = 1/104 H$

Then equation (i) becomes

Volume of water @ $1 m^3$sec in "B" days

$= 86400 B m^3 = 86400 B \times 1/104$ H-m Volume of water.

@ $1 m^3$sec in "B" days $= 8.64 \times B$ H-m

Depth of water required by Crop, A = Volume

Area $A = 8.64 \times B$ H-m/D $H A = 8.64 \times BDm$

## F.P.S System

Let,

Duty = D (Acres/Cusec)

Delta = A feet Base period = B days

By definition

- Now the volume of water applied to this crop during B days = V = (24x60x60xB) $m^3$
  = 86,400 B $m^3$.
- By definition of duty, 1 $m^3$ of water supplied for B days matures D hectares of land. This quantity of water (V) matures D ha of land or $10^4 D m^2$ of area

Total depth of water applied on this land

= Volume/area = $86400 B / 10^4 D = 8.64 B/D$ m.

By def. this total depth of water is called Delta Δ.

Therefor $\Delta = 8.64 B/D m = 864 B/D$ cm

where Δ is in cm, B is in days,

D is duty in ha/cumec

In FPS units $\Delta = 1.98 B/D$ Ft

where Δ is in ft, B in days and D is in Acres/cusec.

Q.1.b)

Sol:-

Given data:-

Water requirement of wheat = 9cm

Days Interval = 35 days

Base period = 140 days

Required data:-

Delta of wheat ($\Delta$) = ?

35 days = 9cm

140 days = $\Delta$

$$\Delta = \frac{9\text{cm} \times 140\text{ days}}{35\text{ days}}$$

$$\boxed{\Delta = 36\text{ cm}}$$

Q.1.c)

Ans:-

## Indus Water Treaty:-

It is a water distribution treaty between India and Pakistan, decided by the World Bank for usage of water available in the Indus system of Rivers located in India. The Indus Waters Treaty (IWT) was contracted in Karachi on 19th September, 1960 by the prime Minister of India Pandit Jawaharlal Nehru and then President of Pakistan Ayub Khan.

According to this agreement control over the water flowing in three "estern rivers" of India the Beas, the Ravi and the Sutlej with the mean annual flow of 33 million acre-feet (MAF) was given to India, while control over the water flowing in three "western rivers" of Indus, the Chenab and the Jhelum with the mean annual flow of

80 mean annual flow was given to Pakistan.

Q.1.D:-

Ans:-

## Significance of Duty of a 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.

$$Q = A/D, \quad A = QD$$

| Crop | Duty in hectares/cumec |
|---|---|
| Sugar Cane | 730 |
| Rice | 775 |
| Rabi | 1800 |
| Hot fodder | 2200 |

Q.2.a)

Ans:- Factor affecting Consumptive Use:-

There are Five types

. Temperature.
. Humidity In Air.
. Velocity of wind.
. Soil Topography.
. Sunlight etc.

. Temperature:-

As the temperature increases, the saturation vapor pressure also increases and results in increase of evaporation and thus consumptive use of water.

Humidity In Air:-

The more the air humidity. The less will be the rate of consumptive use of water. This is because water vapor moves from the point of high moisture content to the point of low moisture content. So if the humidity is high

water vapor cannot be removed easily.

. Velocity of wind:-

The more the velocity of wind, the more will be the rate of evaporation because the saturated of air containing the water will be removed easily.

. Sunlight:

The longer the duration of the sunlight hour the larger will be the total amount of energy received from the sun. The increases the rate of evaporation and thus the rate of consumptive use of crops.

Q.2.b):-

Sol:-

**Given data:-**

Useful Rainfall (cm) = 10

Water application Efficiency ($\eta_a$) = 80% = 0.8

Cummulative Consumptive use (Cu) = 40 cm

**Required data:-**

Field Irrigation Requirement (FIR) = ?

**As we know that,**

⇒ Consumptive Irrigation Requirement (CIR) = Cu - Re

= 40 - 10

CIR = 30 cm

⇒ Field Irrigation Requirement (FIR) = $\frac{CIR}{\eta_a}$

= $\frac{30}{0.8}$ = 37.5 cm.

**FIR = 37.5 cm**

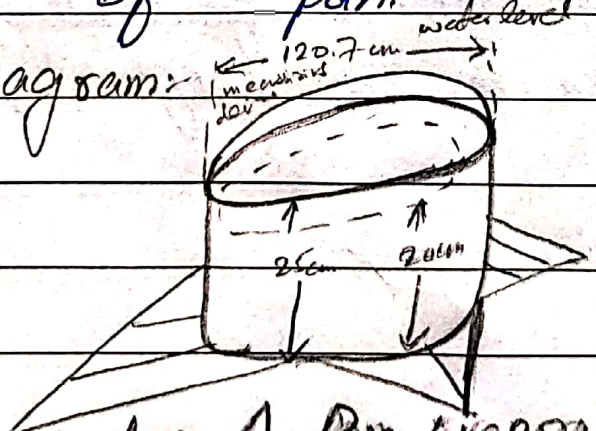
Q.2.c)

Ans:-

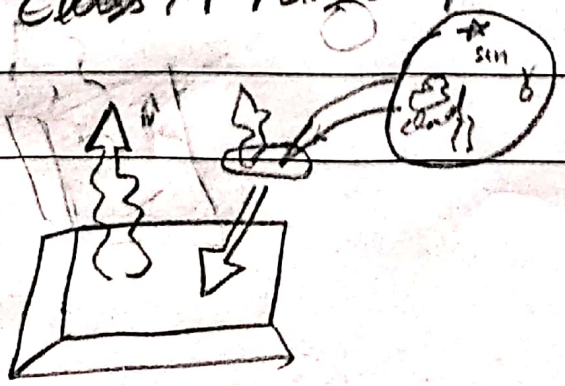
Class A Pan Evaporation (EP) Measurement:

Ep can be experimentally determined by directly measuring the quantity of water evaporated from this Standard class a pan. This pan is 1.0m in diameter, 25cm deep, and bottom is raised 15cm above the ground surface. The depth of water is to be kept in a fixed range such that the water surface is at least 5cm, and never more than 7.5cm, below the top of pan.

Diagram:-




Class A Pan Evaporation



Q.2.d)

Ans:- **CROPING SEASONS**

1- RABI - 1st october to 31st March - Winter

2- Kharif - 1st April to 30st September - Summer

Kharif Crops: Rice Bajra Jawar Maize Cotton.

Rabi Crops: Wheat, Barley, Gram, Mustard Potatoes.

Kharif Rabi Ratio:

The area to be irrigated for rabi crops generally more than that for Kharif crops. This ratio of proposed areas, to be irrigated in Kharif season to that in Rabi season is called, Kharif Rabi ratio. This ratio is generally 1:2. i.e Kharif area is one half of Rabi area.

Q.3. a)

Ans:- **Field Capacity:** (F.C)

**Definition:-**

When all gravity water has drained down to water table, a certain amount of water is retained by surface soil. This water which cannot be easily drained under the action of gravity and is called Field capacity.

Period of drainage = 2-5 days

FC is measured after 2 or 5 days

Field Capacity:

1. Capillary water
2. Hygroscopic water.

**1. Capillary water:**

water attached to soil by surface tension, which can be easily extracted by plants by capillary action.

2. Hygroscopic water:

Water attached to soil by chemical bonds, which can not be extracted by plants by capillary action.

Field Capacity = (weight of water retained in a certain volume of soil)/(wt. of same volume of soil) x 100. Consider 1 Sq.m area of soil, d m depth of root zone.

Volume of soil = d x 1 cu.m

If $\gamma$ kg/cu.m = density of soil = specific wt. of soil

Then wt. of d cu.m of soil = $\gamma$d kg, If F is field capacity.

F = wt. of water retained in unit area of soil/$\gamma$d

wt of water retained in unit area of soil

= F$\gamma$d kg/cu.m

wt of water retained in unit area or volume

= wd1 = $\gamma$d.F

d1 = depth of water stored in root zone =

$\gamma$d.F/w = kg/sq.m/kg/cu.m = m; w =

Specific wt of water = kg/cu.m.

Q.3.b):-

Ans:- Permanent wilting point: (P.W.P)

A plant can extract water from soil till a permanent wilting is reached. P.W.P is that water content at which a plant can no longer extract sufficient water for its growth and wilts up.

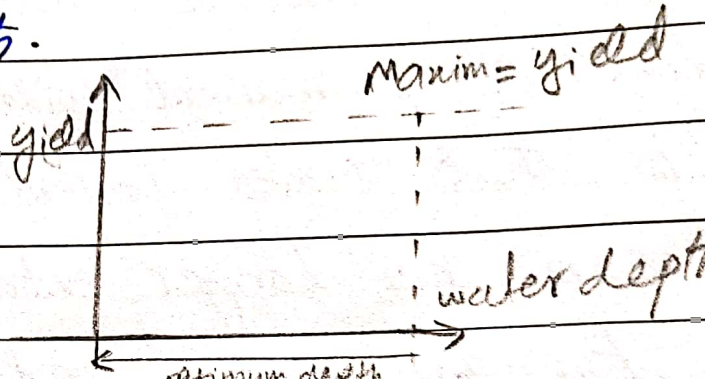
c) Readily Available Moisture:-

It is that portion of available moisture which is most easily extracted by plants and is approximately 75 to 80% available moisture.

D) Optimum Utilization of water:-

If a crop is sown and produced under absolutely identical conditions using different amounts of water depths, the yield is found to vary. The yield increases with water, reaches a certain maximum value & then falls down as shown in following fig.

The quantity of water at which the yield is maximum is called optimum water depth.




## Irrigation Efficiencies:-

Efficiency is the ratio of water output of water to the water input and is usually expressed as percentage.