MODEL ANSWER

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE

SEMESTER END EXAMINATION

B.Sc. (Hort.)

Semester: II (New)
Course No.H/ENGG-121
Credits: 2(1+1)
Day & Date:

Academic year: 2018-19
Title: Water Management in Horticultural Crops
Total Marks 40 Time 2hrs

Note - 1. Solve **ANY EIGHT** questions from **SECTION "A"**.
2. All questions from **SECTION "B"** are compulsory
3. All questions carry equal marks
4. Draw neat diagrams wherever necessary

MODEL ANSWER

SECTION "A"

1 Write about water requirement in horticultural crops. Discuss about the factors affecting water requirement of horticultural crops.

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The estimation of the water requirement (WR) of crops is one of the basic needs for crop planning on a farm and for the planning of any irrigation project. Water is mainly needed to meet the demands of evapotranspiration (ET) and the metabolic activities of plant, both together known as consumptive use (C or U). Since the water used in the metabolic activities of the plant are negligible, ET is practically considered equal to Cu.

Water requirement defined Water requirement may be defined as the quantity of water, regardless of its source, required by a crop or diversified pattern of crops in a given period of time for its normal growth under field conditions at a place.

Water requirement, includes the losses due to ET (or CU) plus the losses during the application of irrigation water and the quantity of water required for special operations such as land preparation.

It may be formulated as follows:

WR= ET or CU + application losses + special needs.

Based on the sources of water supply to meet the water requirement, numerically it is represented as,

$$WR=IR+ER+S \text{ i. e.,}$$

Irrigation water (IR), effective rainfall (ER) and soil profile contribution (S).

Classification of consumptive use of water

Daily consumptive use: The amount of water consumptively used during 24 hour period is called the daily consumptive use.

Peak period consumptive use: The average daily consumptive use during a few days (usually 6 to 10 days) of the highest consumptive use in a season is called the peak period consumptive use.

Seasonal consumptive use. The amount of water consumptively used by a crop during the entire growing season or crop period is called the seasonal consumptive use.

Classification

Factors affecting water requirement:-

1. Soil factor 2. Plant factor 3) Climate factor. 4. Other general conditions

Climatic factors: Radiation, precipitation, relative humidity, temperature and wind

Soil factors

Soil factors such as texture, hydraulic conductivity, water holding capacity, crop residues on the soil surface, colour and rough surface of the soil affects the ET.

Plant factors

Plant morphology, crop, variety, crop geometry, extent of plant cover, stomatal density, duration of the crop, rooting characteristics, growth phase, crop growing season, etc

Cultural practices

Weed control is necessary to reduce the water loss through transpiration by weeds. Fertilizer application increases the ET and CU by producing greater biomass and developing a deeper and extensive root system. However, the CU does not vary widely between well-fertilized and under - fertilized crops.

Mulching

Reduces the ET by reducing the evaporation from the bare soil, reflecting the solar radiation and reducing the weed infestation. Mulching has a greater effect in reducing the ET when the crop cover is relatively small.

Write on water resources of India and important functions of water in plant metabolism.

Water resources of India

1. Sources of all water are precipitation.
2. The annual precipitation of India, including snowfall, is estimated at 1200 mm which is equal to 4000 km3 or 400 million hectare- metres (mha-m).
3. Surface water bodies include rivers, canals, reservoirs, tanks, ponds , lakes and brackish water.
4. In irrigated ecosystem, reservoirs account for 2.1 M ha, tanks and ponds 2.3 M ha, wells, lakes, and direct water bodies 1.3 M ha and brackish water bodies 1.2 M ha.
5. Replenish able ground water resource is mostly derived from precipitation.

6. Out of 400 mha-m, 215 mha-m of rain water percolates in to the ground, out of which only 50 mha-m join the ground water and available for utilization.

Functions of water in plant metabolism.

1. Water is a structural constituent of plant cells and it maintains the cell form through turgor pressure. When plenty of water is available, cells are turgid and plants retain their structural form. Water accounts for the largest part of the body weight of an actively growing plant and it constitutes 85-90 per cent of body weight of young plants and 20 to 50 per cent of older or mature plants.

2. Water is a source of two essential elements, oxygen and hydrogen required for synthesis of carbohydrate during photosynthesis.

3. Water serves as a solvent of substances and a medium in plants allowing metabolic reactions to occur. It also acts as a solvent of plant nutrients and helps in uptake of nutrients from soils. Plants also absorb nutrients through leaves from nutrient sprays.

4. Water acts as a carrier of food materials synthesized in plants.

5. Transpiration is a vital process in plant and it occurs at a potential rate as long as water is available in adequate amount.

6. Adequate supply of water maintains the turgor pressure of guard cells helping stomata to open fully. Water deficit, on the other hand, closes stomata partially or completely reducing water loss through transpiration.

7. Water deficit slows down the growth processes.

8. Leaves get heated up with solar radiation. Plants dissipate heat by increased transpiration. Water act as a buffer against high or low temperature injury as it has high heat by vaporization and high specific heat.

9. Water, when available in plenty, encourages good growth, development and yield of plants. Conversely, plants die when water supply is curtailed down.

Write in brief about any two criteria for scheduling of irrigation to horticultural crops.

Approaches in irrigation scheduling

Several approaches in scheduling irrigation have been used by scientists and farmers throughout the world, each one having its own advantages and disadvantages

1) Use of indicator plant
2) Critical growth stages
3) Soil moisture depletion
4) Climatological approach

1. Soil moisture depletion

The degree of depletion can be assessed by available soil moisture estimation through gravimetric, tensiometer, and resistance block and neutron probe methods. These approaches are reliable, but cannot be recommended to farmers since the means to measure soil water content or soil moisture tension is not easily available.

2. Climatological approach

The amount of water lost through evapotranspiration (ET) is estimated from Climatological data and when ET reaches a particular level, irrigation is scheduled.

The most widely used approach for scheduling irrigation based on Climatological data is termed as IW/CPE ratio method.

In IW/CPE ratio approach, a known amount of irrigation water (IW) is applied when the Cumulative Pan Evaporation (CPE) from an USWB open pan evaporimeter reaches a pre-determined level.

Enlist different irrigation systems followed in horticultural crops. State the advantages of drip irrigation systems.

Methods of irrigation are broadly grouped under:
Surface irrigation

1. Wild flooding
2. Border irrigation
3. Furrow irrigation
4. Check or Check Basin irrigation
5. Basin and ring irrigation

2. Subsurface or sub irrigation
3. Overhead or sprinkler irrigation

4. Drip irrigation

Advantages drip irrigation systems.

1. Fertilizer and nutrient loss is minimized due to localized application and reduced leaching.
2. Water application efficiency is high if managed correctly.
3. Field levelling is not necessary.
4. Fields with irregular shapes are easily accommodated.
5. Recycled non-potable water can be safely used.
6. Moisture within the root zone can be maintained at field capacity.
7. Soil type plays less important role in frequency of irrigation.
8. Soil erosion is lessened.
9. Weed growth is lessened.
10. Water distribution is highly uniform, controlled by output of each nozzle.
11. Labour cost is less than other irrigation methods.
12. Variation in supply can be regulated by regulating the valves and drippers.
13. Fertigation can easily be included with minimal waste of fertilizers.
14. Foliage remains dry, reducing the risk of disease.
15. Usually operated at lower pressure than other types of pressurized irrigation, reducing energy costs.

Discuss in brief about drip fertigation. State the advantages of drip fertigation.

"Fertigation" is a word of recent origin and is a combination of clipped words of fertilizer and irrigation. So also this method combines the application of water and plant nutrients effecting both water and fertilizers saving and enhancing yields and quality of crops simultaneously.

Characteristics of fertilizers for fertigation

The success of fertigation depends primarily on the characteristics of the fertilizers used.

1. Must be completely soluble in water (< 0.02% insoluble in water) and have quick dissolution in water with minimum content of conditioners.
2. Must not react with dissolved elements in water especially calcium and magnesium salts.
3. High nutrient content in the saturated solution must not get leached down easily from the soil.
4. Should not change the pH of water leading to precipitation and clogging

5. Should avoid corrosion of the system
6. Should be safer for field use and for mixing with other chemicals.

Sources of nutrients

1. **Nitrogen:** Urea, ammonium nitrate and ammonium sulphate nitrogenous fertilizers are suggested for fertigation.

2. **Phosphorus:** Generally the application of phosphatic fertilizers through the drip irrigation system is not recommended because in majority of the cases basal application of phosphorus satisfies the plant P needs. Applied phosphorus creates chemical and physical precipitation leading to clogging problems. Phosphoric acid being soluble with low pH, no clogging occurs with orthophosphate. Inorganic phosphorus like Mono Ammonium phosphate and Di ammonium phosphate are the other sources of phosphorus for fertigation.

3. **Potassium:** Potassium is easily soluble in water, easily leached in sandy soils and can be fed through drip irrigation to maintain a proper N: K ratio for crop production. Potassium as potassium sulphate, potassium chloride, potassium nitrate and mono potassium phosphate may be used through drip irrigation since these are soluble in water and do not cause any precipitation problem. Among the different fertilizers, sulphate containing fertilizers can cause problems if irrigation water contains lot of calcium by forming insoluble calcium sulphate. Chloride containing fertilizers should not be used on certain crops like strawberry and tobacco. Phosphatic fertilizers can also become insoluble at high pH, of forming relatively insoluble calcium and magnesium phosphate.

Advantages of Drip fertigation

1. Improves efficiency in fertilizer use. Generally 60 to 80 per cent of the recommended dose of fertilizers through water soluble form was observed to be sufficient and secure equivalent yields of crops as obtained with the application of 100 per cent straight fertilizers.

2. High nutrient availability due to maintenance of soil moisture near field capacity under drip irrigation.

3. Fertilizers could be applied as frequently as possible and at those stages of crop growth when the demand is maximum.

4. Higher water use efficiency and 30 to 40 per cent economy in the use of irrigation

Q.6 Define Evapo-transpiration. Discuss in brief about classification of Evapo-transpiration and factors affection on Evapo-transpiration.

Answer: **Evapotranspiration**

Evapotranspiration denotes the quantity of water transpired by plants during their growth, or retained in the plant tissue, plus the moisture evaporated from the surface of the soil and the vegetation.

Classification of Evapo-transpiration.

1. **Potential evapo-transpiration (PET):** The term denotes the highest rate of evapotranspiration (ET) by a short and actively growing crop or vegetation with abundant foliage completely shading the ground surface and abundant soil water supply under a given climate. It integrates the evaporating demand of the atmosphere and refers to the maximum water loss from the crop field.

2. **Reference crop evapo-transpiration (ETo):** The term is used to express the rate of evapo-transpiration from an extended surface of 8-15 cm tall green grass cover of uniform height, actively growing, completely shading the ground and not short of water. The ET is corrected for day and night weather conditions to ETo (adjusted reference crop ET) by multiplying with the adjustment factor.

3. **Actual crop evapo-transpiration (ET crop):** Refers to the rate of evapotranspiration by a particular crop in a given period under prevailing soil, water and atmospheric conditions. It involves the use of a crop factor called, crop co-efficient while computing it from reference crop ET (ETo) estimated by different empirical formulae or evaporation rates from evaporimeters. The ET crop varies under different soil, water and atmospheric conditions and at different stages of crop growth, geographical location and season of the year.

Factors affecting ET

1. **Climatic factors:**

Radiation, precipitation, relative humidity, temperature and wind.

2. **Soil factors**

Soil factors such as texture, hydraulic conductivity, water holding capacity, crop residues the soil surface, colour and rough surface of the soil affects the ET.

3. **Plant factors**

Plant morphology, crop, variety, crop geometry, extent of plant cover, stomatal density, duration of the crop, rooting characteristics, growth phase, crop growing season, etc.

4. **Cultural practices**

Weed control is necessary to reduce the water loss through transpiration by weeds. Fertilizer application increases the ET and CU by producing greater biomass and developing a deeper and extensive root system. However, the CU does not vary widely between well-fertilized and under - fertilized crops.

5. **Mulching**

Mulching reduces the ET by reducing the evaporation from the bare soil, reflecting the solar radiation and reducing the weed infestation. Mulching has a greater effect in reducing the ET when the crop cover is relatively small.

No.7 Discuss in brief about types of Sprinkler irrigation system.

swer **Types of sprinkler system**

On the basis of arrangement for spraying irrigation water, there are two major types of sprinkler systems.

Rotating head system

Small pipe nozzles are placed on riser pipes at uniform intervals along the length of lateral pipe. They are rotated through 90° by hand or hydraulic pump to irrigate a rectangular strip. The most common device to rotate the sprinkler heads is a small hammer activated to the thrust of the water striking against a vane connected to it. The spacing between lateral lines is 15 m when operating at a pressure of 1.7 to 2.8 kg/cm^2 (17 to 28 m of water head).

Nozzle line sprinkler system

It consists of one or more pipes of relatively small diameter having a single row of fixed small nozzles spaced at uniform intervals along the entire length of pipes and supported on rows of posts at a height convenient to spray over crops and can be rotated through 90°. Water is sprayed at a pressure of two to three atmospheres at right angles to the pipeline and at an angle of 45° to the horizontal plane.

Fixed head sprinkler system

Nozzles in this system remain stationary and spray water is in one direction only to which the spray nozzle is directed. The system is used extensively in orchards and nurseries. It has high water application rates. The spray is usually fine which is helpful for irrigating seedlings in nurseries.

Propeller type sprinkler system

The system includes a number of sprinklers mounted on a horizontal pipeline which is held above the crop by a horizontal super structure centrally pivoted over a wheeled platform in a wing like fashion sprinkler pipeline with the super structure propels slowly and sprays a wide area.

Perforated pipe system

This method consists of holes perforated in the lateral irrigation pipes in a specially designed pattern to distribute water fairly uniformly. This system is usually, designed for low operating pressures of about 1.0 kg cm^2 (10 m of water head). The pressure is so low that the system can be connected to an over head tank to obtain the necessary pressure head. The sprays are directed on both sides of the pipe and can cover a strip of 10 to 15 m wide. This system is well suited for irrigating lawns, gardens and small vegetable fields.

Based on the portability, the sprinkler systems are classified into the following types.

Permanent system

This system has stationary water source and pumping unit. Mains, sub mains and laterals are usually buried. Sprinklers are permanently located on each riser. Such systems are costly and suited to automation of the system with moisture sensing devices.

Semi permanent system

This system has portable lateral lines, permanent main lines and sub mains and a stationary water source and pumping unit. Mains, sub mains and laterals are usually buried, with riser for valves located at suitable intervals.

Portable system

This system has portable main lines, laterals and a portable pumping unit. It is designed to be moved from field to field or to different pump sites in the same field. For portability the unit is equipped with wheels.

Semi-portable system

It is similar to portable system except that the location of water source and pumping units are fixed. It can be used on more than one field where there is extended main line, but may not be used on more than one farm unless there are additional pumping units.

Solid set system

This system has enough laterals to eliminate their movement. Laterals are positioned in the field early in the season and remain in the field for the season. It is used for crops requiring frequent irrigations.

58 A lateral has 12 sprinklers spaced 14 metres apart. The laterals are spaced 20 metres on the main line. Determine the amount of fertilizer to be applied at each setting when the recommended fertilizer dose is 80 kg/ha.

wer Here we have

$Ds=14m$, $D_l=20m$, $Ns=12$ and $W_f=80kg/ha$

$W_F=(D_s x D_l x N_s x W_f)/ 10000$

$=(12x20x14x80)/10000$

$=26.88$ kg

9 Calculate the quantity of water required in m^3 per hectare per day for banana using following data

i. Spacing between the plants and row = 1.5mx1.5m
ii. Pan evaporation = 10mm/day
iii. Pan factor =0.70
iv. Crop coefficient =1.0
v. % Wetted area =60

Answer Water requirement = 1.5x1.5x10x1.0x0.60

= 9.45 lit/day/plant

Number of plant =10000/(1.5x1.5)

= 4445

Quantity of water = 4445x9.45

= 42000 lit/day/ha

=42 m^3/day/ha

10 Write short notes on following

i. Border Irrigation
ii. Subsurface irrigation methods

Answer a. **Border Irrigation**

Borders are usually long, uniformly graded strips of land, separated by earthen bunds. The bunds so formed are not to contain the water from ponding but to guide it as it flows down the field. Border irrigation is generally best suited to the larger mechanized farms as it is designed to produce long uninterrupted field lengths for ease of machine operations. Borders can be upto 800 m or more in length and 3-30 m wide depending on a variety of factors. It is less suited to small-scale farms involving hand labour or animal powered cultivation methods. Border slopes should be uniform, with minimum slope of 0.05% to provide adequate drainage and a maximum slope of 2% to limit problems of soil erosion. Deep homogenous loam or clay soil with medium infiltration rates is preferred. Close growing crops such as pasture, alfalfa are preferred. Borders may be either laid along the slope (straight) or across the slope (contour).

b. **Subsurface irrigation methods**

Subsurface irrigation, also designated as sub irrigation, involve irrigation to crops by applying water from beneath the soil surface either by constructing trenches or installing underground perforated pipe lines or tile lines. Water is discharged into trenches and allowed to stand during the whole period of irrigation for lateral and upward movement of water by capillarity to the soil between trenches. Underground perforated pipe or tiles in which water is forced, trickle out water through perforations in pipes or gaps in between the tiles. Water moves laterally and upward to moist the root zone soil under capillary tensions. Pipelines remain filled with water during the period of irrigation. The upper layers of soil remain relatively dry owing to constant evaporation while lower layers remain moist.

The essential pre-requisite for sub-irrigation are:

1. Existence of a high water table or an impervious sub-soil above which an artificial water table can be created
2. Highly permeable root zone soil with reasonably uniform texture permitting good lateral and upward movement of water
3. Irrigation water is scarce and costly and
4. Soil should not have any salinity problem.

It might be ensured that no water is lost by deep percolation. The artificial water table is created to a depth of 30 to 120 cm depending on crops to be grown, nature of soil capillarity and the depth of impervious soil layer. Uniform topographic conditions and moderate slope favour sub-irrigation. In places where sprinkler irrigation is expensive, sub irrigation is adopted. Sub-irrigation is made by constructing a series of ditches or trenches 60 to 100 cm deep and 30 cm wide, the two sides of which are made vertical. Ditches are spaced 15 to 30 m. The crops, particularly with shallow root system are well adapted to sub irrigation. Sometimes, sub irrigation is made to high priced vegetable crops by installing a perforated pipe distribution system below the soil surface but within the crop root zone.

SECTION "B"

1 Define following terms

i. Water use efficiency

The term water use efficiency denotes the production (of crops) per unit of water applied.

ii. Available Water

Soil moisture between field capacity and permanent wilting point is referred to as readily available moisture. It is the moisture available for plant use.

iii. Transpiration

Transpiration is the process by which water vapour leaves the living body, principally the leaves, and enters the atmosphere.

iv. **Net irrigation requirement**
Net irrigation requirement is the amount of irrigation water required to bring the soil moisture level in the effective root zone to field capacity.

Q.No.12 Fill in the following blanks

1 i. The hygroscopic water is held at **31 to 10,000** atmospheric tension.
2 ii. **Filter** is the heart of drip irrigation system (filter)
3 iii. Allowable pressure variation along the drip lateral should be less than **20 %**
4 iv. Sprinkler irrigation method is not suited for soils having infiltration rate less than ≯ 4 mm/h **cm/hr**

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