BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH 509

Department Of Engineering and Physics
Bachelor of Science (Honours) in Agricultural Engineering
Design and Operation of Pressurised Irrigation Systems

3 HOURS (100 MARKS)

JUN 2024

INSTRUCTIONS

Answer any ***FOUR*** questions. Each question carries 25 marks.

Question 1

a. Briefly explain the following terms as used in irrigation:
   i. Command area (=designed area). **[2 marks]**
   ii. Discharge. **[2 marks]**
   iii. Effective root depth (D). **[2 marks]**
   iv. Field capacity (FC). **[2 marks]**
   v. Irrigation cycle. **[2 marks]**
   vi. Leaching requirement. **[2 marks]**
   vii. Net irrigable area. **[2 marks]**

b. Where Sa = 99 mm/m, p = 0.5, D = 0.4 m, determine the net irrigation dose (d) in millimetres to replenish the moisture deficit? **[11 marks]**

Question 2

Explain the parameters and evaluation criteria to be measured when using reclaimed wastewater for irrigation purposes. **[25 marks]**

Question 3

Design a low cost family drip systems in tomatoes (trellised) for a plot, given the preliminary data below

Area and crop

The plot dimensions are 20 x 25 m (500 m^2) planted in the open with tomatoes in rows 1.50 m apart and spaced along the rows 0.60 m. The plot is divided along into two parts, each one having 13 rows 12.5 m long. There are 21 plants per row. So there are 273 plants in every part, i.e. 546 plants in the whole plot and 26 plant rows. Planting is planned to be done in late July/early August and the growing period to be extended up to early next year 140 days approx.). Irrigation stops in late November, but harvesting continues until February.

Soil and water

Medium texture soil with permeability around 12 mm/h and relatively good water holding capacity. The source of water is a nearby shallow hand-dug well equipped with a

small pumping unit; it is of good quality but with low impurities content. Filling of the system's tank is done directly from the well with the use of a PE hose.

Crop water requirements and irrigation schedule

The total irrigation requirements of the tomatoes are around 650 mm. The calculation is made following the FAO methodologies. The irrigation scheduling in this system is not arranged at a fixed moisture depletion of the available soil moisture, but at fixed interval of one day, two and three days. So irrigation takes place frequently and the dose varies according to the stage of growth of the crop. At the last, the harvest stage, the irrigation depends on the effective rainfall and the price of the tomatoes.

In this design the crop is planted in mid summer at the highest Et_o values. It is an extreme case as example, however very common in practice. As already mentioned above, "The frequency of irrigation normally may be from 2-5 days with an average water dosage of 0.5-1 litre/day/plant at the first stage of growth. During the yield formation the dosage increases to meet the requirements of 1-2 litres/day/plant. Later the daily needs increase up to 3-6 litres/day/plant and at late season, sometimes, 5-7 litres/day/plant. Daily applications are needed."

In this case the water demand is very high in the early stages of the crop, although the crop ground cover is limited and increases as the crop is entering the mid and late season stages. (During the crop development and the mid-season stages and the k_c value is 1.0, whilst in the early stages is 0.45 - 0.75. The systems application efficiency is 90 percent. In this design the following irrigation program can be used as a guideline.

: - The irrigation program of the case example

Growing period (stages)	Irrigation demand (mm)	Interval (days)	Dose litres/ plant	Irrigation dose (m³)	Number of irrigations	Total water applied (m³) per 500 m²
30 Jul.-15 Aug.	90	1	5.5	3.0	15	45
16 Aug.-10 Sep.	155	1	5.5	4.0	25	75
11 Sep.-10 Oct.	155	2	9	5.170	15	76
11 Oct.-15 Dec.	210	3	8	4.722	22	104
16 Dec.-15 Jan.	50	Effective rainfall equivalent to ETc				25
TOTAL	660		-	-	77	326

[25 marks]

Question 4

Describe the minimum engineering investigation requirements for a pressurized irrigation system to enable the successful planning, designing and implementation of every irrigation system at the farm level. **[25 marks]**

Question 5

Provide an example for the tenders for the supply of any pressurised irrigation equipment. **[25 marks]**

Question 6

Explain, in detail the main components of a pressurised piped systems **[25 marks]**

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