

Determination of irrigation requirement of crops (calculations)**Scheduling of Irrigation by different Methods**

Irrigation scheduling is the process of determining when, how and how much water to be irrigated. Proper irrigation scheduling indicates the correct time (when to irrigate) and amount of irrigation water at each irrigation. It saves water and energy, boots up yield, and reduces the production cost. Time of irrigation is usually governed by major conditions namely (1) Water need of crops and (2) Availability of irrigation water. Water need of crops is, however, the prime consideration to decide the time of irrigation. There are several approaches for determining when to irrigate the crop. The approaches can be broadly classified into three groups:

- (1) Soil moisture regime approaches
- (2) Climatologic approaches
- (3) Plant indices

(1) Soil moisture regime approaches:

These approaches involve determination of water content of the soil and finding the deficit in available moisture at which it is proposed to irrigate based on pre- determined minimum water content and irrigating to bring the soil to field capacity. The soil moisture content can be known from the following methods:

a) Gravimetric methods:

This is a direct and reliable method, where samples are collected, weighed and dried at 105-110 °C for about 24 hours until constant weight is obtained and reweighed after drying. Details of this method are illustrated in Experiment No. 1.

b) Feel and Appearance:

Soil moisture content can be judged by feel and appearance of the soil, with experience. Soil samples from root zone depth are formed into balls, tossed gently into air and caught in hand. The accruing of judgement improves with experience.

Tensiometers:

Use of tensiometers to determine soil moisture tension and relating to water content of the soil by the characteristic curve was already discussed in Experiment No.1 Electrical resistance

Tensiometers and electrical resistance, methods actually indicate the energy status of soil of water. These are not so popular because of some limitations. Tensiometers have narrow working range 1.0 to 0.8 bar tension whereas gypsum blocks do not work satisfactorily at low tensions.

It is computed by posting everyday ET, effective rainfall, soil water content etc and determining the balance of moisture in the soil. This method is cumbersome and lot of data is required.

Table: Guide for judging the amount of available soil moisture range by Feel and Appearance Method:

SI. No.	Available soil moisture range	Coarse texture soils moderately	Moderately coarse	Medium texture	Fine texture
1	Field capacity (100%)	Free water appears on soil, but wet outline is left on hand	Similar symptoms	Similar symptoms	Similar symptoms
2	75%to 100%	Tends to stick Together slightly sometimes forms a very weak ball under pressure	Forms weak ball breaks easy to not stick	Forms a ball is very pliable slickes readily	Easily ribbon out between fingers has slick feeling
3	50%to 75%	Appears to be dry don't form a ball on pressure	Tends to form ball on pressure but seldom hold	Forms a ball somewhat plastic sometimes	Forms a ball but ribbon out between thumb and

			together	slides with slight pressure	fore finger
4	25%to50%	As above but ball is formed by squeezing very firmly	Appears to be dry don't format ball unless squeezed very firmly	Somewhat crumbly but holds together with pressure	Somewhat pliable forms a ball under pressure
5	0%to 25%	Dry, loose. single grained, flows through fingers	Dry, loose, flows through fingers	Powdered dry but sometimes break down into powdery condition	Hard breaked cracked sometimes has loose crumbs on surface

Climatologic approach:

The atmospheric dryness or evaporative demand of a place actually determines the amount of water transpired from a cropped field. Atmospheric evaporative demand can be estimated using various methods (Penmann's formula, Blannay and Criddle) and correlated with the actual crop water use. Prihar et al. (1974), suggested the use of ratio (s) between irrigation water (IW) and the cumulative pan evaporation (CPE) to schedule irrigation to crops under specific soil and climatic conditions. The quantity of water to be applied at each irrigation will depend on soil and crop characteristics. Dew corrections are to be made for effective rainfall received during the irrigation interval.

Example: Irrigation is schedule at í W/CPE ratio 0.8 and the crop is irrigated to a depth of 6.0 cm. CPE at which irrigation to be scheduled can be calculated as follows: 6.0 m

Depth of irrigation (IW)= 6.0m

$$\text{CPE} = X\text{cm}$$

$$\text{IW/CPE} = 0.8$$

$$\text{So, } \frac{6.0}{x} = 0.8$$

$$\text{So, } x = \frac{6.0}{0.8} = 7.5$$

This crop is to be irrigated when CPE is 7.5 cm

Plant indices:

Monitoring plants is the most direct method of determining when to irrigate. Plant parameters have to be related to soil water content to determine the quantity of irrigation requirement.

Appearance and Growth:

These are not effective parameters to decide the time; of irrigation because the plants exhibit visible symptoms of deficiency long after they experience moisture stress. Deficiency of water stress causes leaf and shoots wilting leaf colour, drooping of leaves and rolling of leaves.

Leaf Temperature:

An infrared thermometer measures the difference between canopy and ambient temperature. The number of degrees by which canopy temperature exceeds air temperature each day is accumulated until a certain level (predetermined) is reached. When the level reaches, it is to be irrigated.

Leaf water potential:

Leaf water potential indicates the plants need for water. Leaf water potential is measured by removing a leaf and placing it in a pressure chamber. The pressure in the chamber is slowly increased until fluid is forced from the leaf. The pressure used is a measure of the leaf's moisture potential. Lower potential indicates a greater need for water. The leaf age, leaf exposure to solar

radiation and time of day when leaf is sampled all significantly influence the results. This method is not extensively used since considerable time, care and training are required to obtain reliable results.

Stomata resistance:

Leaf resistance to vapour diffusion into the atmosphere is primarily governed by the degrees of stomata closure, which under sufficient day light is mainly regulated by leaf water deficits. Stomata resistance is, therefore, an index to the need for water, since it is related to the degree of stomata opening and the rate of transpiration. High resistance generally indicates significant stomata closure, reduced transpiration rates and the need for water. Leaf diffusion parameters are used to measure stomata resistance. The skill required to take measurements and time involved to interpret limit the use of this method for research purposes.

Rough methods for farmers:

Soil-cum-Sand Mini plot technique:

It is also known as Profile modifications. The principle involved in this method is to reduce artificially, the available water holding capacity of soil in root zone depth in the mini plot by mixing sand with it. Plants on sand mixed mini plot show moisture stress symptoms earlier than plants in rest of the area. Usually, an area of 1.0 m² is selected in the field and a pit of 1.0 m depth is excavated in layers of about 15 cm depths is excavated in layers of about 15 cm depths. Each layer of soil is mixed with 5 per cent by volume of sand and the pit refilled in the same sequence of layers as excavated by compacting each layer to bring bulk density of soil in the mini plot as that. of the surrounding area. Symptoms of plants in the mini plot indicate time for irrigating the crop.

Increased plant stand:

An area of about 1.0 m², preferably in a high spot, is sown with the same crop to maintain about four times the plant population compared with that in the surrounding area. Crop with high stand establishment wilts earlier than the crop in the rest of the field indicating timing of irrigation.

Reduction in growth rate of sensitive plant organs may indicate irrigation need of crops. In the case of orange plants, irrigation is given when the growth rate of fruit circumference falls below

0.2 to 0.3 mm day". Since stem elongation of crops like sugarcane, tomato and cotton is highly correlated with water stress, it is possible to use this character as an indication of irrigation needs. Relative leaf water content plant water potential, stomata resistance and plant temperature, which can adequately reflect the internal water balance of the plant, may be used as potential indicators for scheduling crop irrigation.

Problem:

1. Schedule irrigation in crop (Name) based on pan evaporation of Pantnagar metrological laboratory on the basis of following points.

Irrigation water to be applied = 7.0 cm.

$$\text{IW/ CPE ratio} = 0.9$$

Date of sowing of (crop) wheat = 15 Nov. 2002

Ist irrigation it means we will irrigate the wheat crop when CPE reaches 77.8 mm. In the above table CPE reaches 77.5 mm on 12th December 2002. therefore, irrigation will be given on 12th December.

Likewise, IInd irrigation and so and so.

Note:

1-Irrigation treatments based on IW/ CPE ratio should be started after giving a common irrigation. 2- Effective rainfall should be considered while planning irrigation treatment based on IW/CPE ratio.

For winter R.F.x 1.66 Pan evaporation equivalent

For summer R.Fx1.25 = Pan evaporation equivalent

Pan equivalent should be subtracted from CPE and irrigation should be at same treatment CPE.

Adjustment of rainfall IW/CPE=ratio

IW=1 depth of irrigation water or irrigation water

IW/CPE =0.6 at this irrigation is scheduled

1.0

CPE=1.66 0.6

1.66x r.f. =x

Add in CPE of that treatment and delay the irrigation.

Practical significance:

Conclusion:

Signature of Faculty In-charge