Principles of Irrigation Scheduling of Crop

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Introduction

Irrigation scheduling is the process used by irrigation system managers to determine the correct frequency and duration of watering, correct amount of time in which water or labor may be available for irrigation. Irrigation scheduling can be defined as "the process of determining when to irrigate and how much water to apply, based upon measurements or estimates of soil water or water used by the plant". Scheduling irrigation is very critical for obtaining optimal crop yields. For optimum irrigation scheduling, sound knowledge of the soil water status, crop water requirements, crop water stress status, and potential yield reduction under water-stressed conditions is prerequisite to maximize profits and optimize the use of water and energy.

The factors may be taken into consideration:

- ***Precipitation rate of the irrigation equipment*** – how quickly the water is applied, often expressed in inches or mm per hour.
- ***Distribution uniformity of the irrigation system*** – how uniformly the water is applied, expressed as a percentage, the higher the number, the more uniform.
- ***Soil infiltration rate*** – how quickly the water is absorbed by the soil, the rate of which also decreases as the soil becomes wetter, also often expressed in inches or mm per hour.
- ***Slope (topography) of the land*** being irrigated as this affects how quickly runoff occurs, often expressed as a percentage, i.e. distance of fall divided by 100 units of horizontal distance (1 ft of fall per 100 ft (30 m) would be 1%).
- ***Soil available water capacity*** expressed in units of water per unit of soil, i.e. inches of water per foot of soil.
- ***Effective rooting depth*** of the plants to be watered, which affects how much water can be stored in the soil and made available to the plants.
- ***Current watering requirements*** of the plant (which may be estimated by calculating evapotranspiration (ET), often expressed in inches per day.
- Amount of time in which water or labor may be available for irrigation.
- Amount of allowable moisture stress which may be placed on the plant. For high value vegetable crops, this may mean no allowable stress, while for a lawn some stress would be allowable, since the goal would not be to maximize production, but merely to keep the lawn green and healthy.
- Timing to take advantage of projected rainfall

- Timing to take advantage of favorable utility rates
- Timing to avoid interfering with other activities such as sporting events, holidays, lawn maintenance, or crop harvesting.

The goal in irrigation scheduling is to apply enough water to fully wet the plant's root zone while minimizing overwatering and then allows the soil to dry out in between watering, to allow air to enter the soil and encourage root development, but not so much that the plant is stressed beyond what is allowable.

***The basic principles of irrigation scheduling from a soil-water view are*:**

1. Soil moisture

Sites for monitoring soil moisture should be chosen to be most representative of the field. The purpose is to limit under-watering of the heavier soils and over-watering lighter soils. For precision irrigation where watering can be controlled in smaller areas within the field, more monitors would be needed and both better and poorer soils would need to be monitored.

2. Root zone depth

Root zone depth is the zone where most of the root structure is found. The irrigation technique known as partial root-zone drying has proved to hold the potential to increase water use efficiency without significantly reducing yields. The technique essentially involves irrigating approximately half of the root system of a crop while the other half is left to dry.

3. Water holding parameters

Two measurements would be important. The "fill point" is the wettest a soil can be before water drains below the root zone. This would be near 100% field capacity (FC) or 100% holding capacity of the root zone and depends on soil texture. In general, sandy soils have the lowest FC while silt loams have the highest with clays being intermediate. The "refill point" is the driest a soil can be before daily water use is lowered due to too little water in the root zone. This begins to induce the shutting of stomata's resulting in reduction of carbohydrate synthesis (photosynthesis) and respiration (metabolism), and leads to wilting. This has a direct relation to yield. The difference between field capacity and 40% depreciation is the "allowable depletion" (AD) amount of water and, for potato, is 20-25% FC or about half the total available water (about 40% FC). In sandy loam soils, the AD is three-quarters to one-inch water up to a depth of 12 inches or one to one and a half inch for the root zone (Curwen and Massie, 1994; Yonts and Klocke, 1985). Soils that are compacted or tend to seal will lower water-holding capacity and reduce penetration of water into the soil.

4. Effective irrigation

Effective irrigation is the amount of water that actually gets into the root zone and is available to the plant. Some of the irrigation water (actual irrigation) is lost as run-off, evaporation or deep percolation.

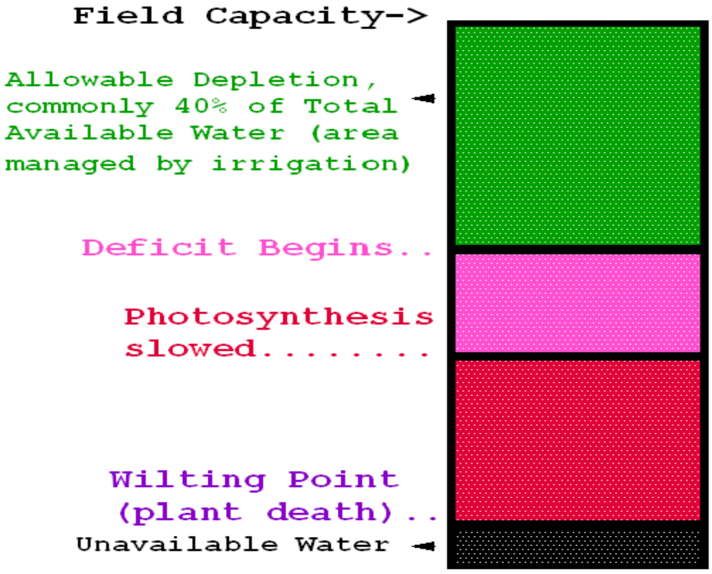
5. Daily water use

Daily water usage by the crop is dependent on the growth stage of the plant and environmental conditions on that day. It is directly related to canopy development, mostly leaves which contain nearly all the stomata. Environmental conditions that affect daily water use are air temperature, relative humidity, wind, and solar radiation. An excellent guide to daily water usage is evapotranspiration (ET) data that is calculated from weather station data (Klocke et al., 1990). ET is the total daily water use from both transpiration by the plant and evaporation from the soil.

In summary, the key factors in managing irrigation are:

- How much water gets into the soil?
- How much water the soil can hold?
- How much water is being used by the plant?

Figure 1. Allowable depletion and available water.



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