Irrigation Scheduling:
The water budget method

CIMIS (California Irrigation Management Information System) is an integrated network of 145 automated weather stations located throughout California. Irrigation information and weather data is provided free of charge by the Water Use and Efficiency Branch of the California Department of Water Resources.

CIMIS helps agricultural growers and landscape supervisors manage their water resources more efficiently. CIMIS supplies the data used to determine when to irrigate and how much water to apply. Efficient use of water resources benefits Californians by saving water, energy, and money.

Irrigation Scheduling

A major part of any irrigation management program is deciding when to irrigate and how much water to apply to the field. This decision-making process is referred to as irrigation scheduling.

The water budget method of irrigation scheduling, using the CIMIS reference evapotranspiration (ETo) values, can be simplified into three steps:

- The initial balance of water in the soil is determined by direct observation or a thorough wetting of the root zone soil by irrigation or winter rains.
- Daily quantities of crop water use (ETc) are subtracted until the soil water is reduced to a desired level.
- An irrigation amount equal to the accumulated ETc used since the last irrigation is applied, the soil profile is recharged to full capacity, and the cycle begins again.

After the soil profile is fully charged, some excess water is drained down and out of the plant root zone by gravity. The quantity of water remaining in the root zone after drainage is referred to as field capacity. Only a portion of the water content, known as available water (AW), can be potentially taken up by the crop. The goal is to prevent yield-reducing crop water stress by maintaining the soil water content above a certain level. This is accomplished by keeping track of soil water content and knowing how dry the soil can get before yield-reducing crop stress, also known as yield threshold depletion (YTD), occurs. The value of YTD is mainly dependent upon crop sensitivity to water stress and root density.

The ultimate choice of how much water to deplete before irrigating is made by the irrigation manager and is influenced by cultural practices, labor, water deliveries, or other considerations. Irrigation is timed

depending on a management allowable depletion (MAD), which is the percent of available water which the irrigator will allow plants to deplete before irrigating or the depth of water that the irrigator will allow plants to extract from the root zone between irrigations. Generally, the MAD is selected to be less than or equal to the YTD.

ETc can be calculated with ETo from CIMIS and a crop coefficient (Kc) as ETc = ETo x Kc and used to determine soil water depletions from field capacity to MAD. The following table demonstrates how a water budget would be calculated for a seed alfalfa field with the following properties: AW = 5.0 inches, MAD= 50% of AW = 2.5 inches, and YTD = 2.6 inches.

The water budget record in the example table begins on July 1 with the total water content at field capacity or 2.5 inches MAD. On each day, ETc is added to the depletion on the previous day to obtain a new depletion value. A net of 2.50 inches was applied on July 11 because the depletion from field capacity was going to exceed both MAD and YTD. Effective rainfall, or amount of rainfall that contributes to the soil reservoir on July 13 and 14 was recorded and the depletion was adjust accordingly.

Date	Effective Rainfall	Irrigation	Crop ET	Cumulative Crop ET	Depletion
July 2	0.00	0.00	0.30	0.30	2.20
July 3	0.00	0.00	0.19	0.49	2.01
July 4	0.00	0.00	0.22	0.71	1.79
July 5	0.00	0.00	0.28	0.99	1.51
July 6	0.00	0.00	0.25	1.24	1.26
July 7	0.00	0.00	0.26	1.50	1.00
July 8	0.00	0.00	0.28	1.78	0.72
July 9	0.00	0.00	0.32	2.10	0.40
July 10	0.00	0.00	0.36	2.46	0.04
July 11	0.00	2.50	0.40	0.36	2.14
July 12	0.00	0.00	0.22	0.58	1.92
July 13	0.42	0.00	0.11	0.27	2.23
July 14	0.25	0.00	0.15	0.17	2.33
July 15	0.00	0.00	0.25	0.42	2.08

NOTE: All numbers in the table are in inches.

Irrigation System Efficiency

The water budget method of irrigation scheduling can be used to determine when to irrigate and how much water to replenish. It does not determine how much water should be applied through the irrigation system or how long the irrigation system should be operated to apply the water.

Determining the amount of water to actually apply through the irrigation system is done by dividing the amount of water required to replenish the soil reservoir by the efficiency of the irrigation system. Water that runs off the field or percolates below the root zone due to non-uniformity of the irrigation system does not contribute to the soil reservoir.

For example, if 30 percent of the water applied runs off the field or percolate below the root zone, the irrigation efficiency is 70 percent and the required applied water for the July 11 irrigation in the above table would be 2.50 inches/0.70 = 3.57 inches. Therefore, the grower should apply a depth of approximately 3.6 inches to replenish the soil reservoir over the entire field. Any application of water over 3.6 inches would result in either excess runoff or percolation below the root zone.

Many resources are available to help you create an irrigation schedule that meets your specific needs.

Further help is avilable on the CIMIS website wwwcimis.water.ca.gov.