drought tips

Number 92-43

Deciding How Much to Plant During A Drought

The most effective response to a severe drought is to reduce planted acreage. If a crop's net application requirement, the application efficiency of the irrigation system, and the quantity of irrigation water available from a water district or wells are known, acreage to plant can be determined by calculating a water balance. The method described here assumes that sufficient water will be applied to avoid yield-reducing water stress.

In a water balance, the total water additions (from all sources) must equal the total water losses. One component of the water balance is the required gross application amount (or applied water), which can be determined if the other components are known. If one knows the quantity of water available for irrigation, the acreage to plant can then be calculated.

Water Balance Calculations

Sources of water for a crop include (1) pre-season usable soil water, (2) water tables, (3) fog interception, (4) effective rainfall, and (5) applied irrigation water. Losses of water from an irrigated crop include crop water use (crop evapotranspiration), and irrigation application losses. Since the total losses equal the total additions, the following equation applies:

$$AL + ETc = AW + PW + WT + F + ER \qquad \textbf{(1)}$$

where

AL = application losses
ETc = crop evapotranspiration
AW = gross application (applied water)
PW = pre-season stored soil water
F = fog interception
ER = effective rainfall

Rearranging equation 1, the requirement for applied water is calculated as:

$$AW = ETc - (PW + WT + F + ER) + AL \qquad \textbf{(2)}$$

or as:

$$AW=NA+AL \qquad \textbf{(3)}$$

where NA = ETc - (PW + WT + F + ER) is the net application requirement. The net application requirement is calculated from estimated water balance parameters, and the application losses are approximated using a seasonal estimate of application efficiency.

Application efficiency is the ratio of applied water stored for use by the crop to the total applied water. If the irrigations are well managed, the application efficiency will approximately equal the net application requirement divided by the applied water. Therefore, the application efficiency (AE) is estimated as:

$$AE = NA + AW \qquad \textbf{(4)}$$

and AW is calculated using the equation:

$$AW = NA + AE \qquad \textbf{(5)}$$

From Equation 3, the application losses equal the difference between applied water and the net application requirement:

$$AL = AW - NA \qquad \textbf{(6)}$$

and using Equations 5 and 6, the application losses are calculated as:

$$AL = (NA + AE) - NA \qquad \textbf{(7)}$$

Pre-season Usable Soil Water

Pre-season usable soil water is calculated as the difference between the pre-season water content within the full crop root zone and the expected end-of-season soil water content. Pre-season soil water content can be measured or estimated. The expected end-of-season soil water content depends on district delivery constraints, crop factors, irrigation method, soil considerations, and labor. Generally, the end-of-season soil water content will be greater than 75 percent of field capacity. Therefore, if field capacity is 10 inches, the end of season soil water content is typically between 7.5 and 10

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inches. Crops that are sensitive to water stress end the season with a water content closer to field capacity. Also, fields immediately replanted to another crop often end with a higher final water content. When a field is not planted during the rainy season, a lower end-of-season soil water content is possible.

Water Table Contributions
Although the amount of water provided is difficult to estimate, upward movement of water from water tables can contribute to crop water needs. During a drought, water tables often drop and thereby contribute less. See ***drought tips*** 91-27 for more information on water table contributions.

Fog Interception
In foggy areas, water intercepted by plants from the fog can provide some of a crop's water needs. Although daily amounts from fog may be small, the cumulative effect can be significant. Fog is intercepted by and coats the plants, and evaporation of the intercepted water substitutes for water removal from the soil. The amount of water supplied by fog is estimated using the approximate time of day when fog dries off the crop, which is an estimate of crop evapotranspiration (ETc). See ***drought tips*** 91-40 for more information on how to estimate fog interception contributions to crop water needs.

Effective Rainfall
Effective rainfall occurs during the growing season and either coats the plants or is stored in the crop root zone where it contributes to crop water use. Surface runoff and percolation of excess water below the crop's root zone are not effective rainfall. Surface runoff is difficult to estimate, but is generally small during the main growing season of most California crops. Deep percolation of rainfall depends on the soil water content before the rainfall and the amount of rainfall that infiltrates into the soil. Effective rainfall cannot be greater than the soil water depletion before the rainfall, so the management allowable depletion—the soil water depletion level a grower decides not to exceed between irrigations—provides an upper limit for effective rainfall. For example, if a grower never allows more than two inches of soil water depletion between irrigations, the effective rainfall cannot be greater than two inches.

Applied Water (or Gross Application)
Applied water is the main source of water for most California crops. When determining acreage to plant, the objective is to use a water balance to calculate the applied water requirement. This value is then used with an estimate of the available irrigation water to determine the acreage.

Calculating Acreage to Plant
After the applied water requirement is determined using Equations 2 and 7, the area to plant can be calculated by dividing the available irrigation water (IW by the applied water (AW). If the applied water is calculated in inches, the amount is divided by 12 to convert to acre-feet per acre and then the available irrigation water (IW) is divided by the applied water to determine the number of acres to plant.

ACRES = IW+ (AW+ 12) **(8)**

Sample Calculations:

Given the following data:

— Crop evapotranspiration (ETc) = 27 inches
— Pre-season usable water (PW) = 4 inches
— Fog interception (F) = 1 inch
— Effective rainfall (ER) = 2 inches
— Water table contribution (WT) = 0 inches
— Application efficiency (AE) = 80 percent
— Irrigation water (IW) available = 1000 acre feet,

Calculate the acreage to plant.

Step 1: Net application
NA = ETc - (PW + WT + F +ER)
NA = 27 - (4 + 0 + I + 2) = 20 inches

Step 2: Application losses
AE = 80% = 0.80
AL = (NA + AE) - NA
AL = (20 + 0.80) - 20 = 5 inches

Step 3: Applied water (or gross application)
AW=NA+AL
AW = 20 + 5 = 25 inches

Step 4: Acres to plant
AW = 25 inches + 12 inches per foot
2.083 acre-feet per acre
Acres = IW + AW
Acres = 1000 -1- 2.083 = 480 acres

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