Irrigation Scheduling Program for Alfalfa

R.L. Snyder, Biometeorology Specialist
K.M. Bali, Farm Advisor, Imperial Co.

2008 California Alfalfa & Forage Symposium and Western Alfalfa Seed Conference 2-4 December 2008 | San Diego, CA
Water Balance

IRRIGATION

RAIN, FOG, DEW

ET

STORAGE

PERCOLATION

WATER TABLE

RUNOFF
Actual Evapotranspiration

\[ ET_o \times K_c = ET_c \times K_s = ET_a \]
Estimating $ET_o$

\[
ET_o = \frac{0.408 \Delta (R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma (1 + 0.34 u_2)}
\]

$ET_o$ accounts for weather
Approximates pasture $ET_c$
CIMIS $\approx$ Penman Monteith

Penman Monteith Eq.
ASCE-EWRI Committee on Evapotranspiration in Irrigation and Hydrology
Allen et al. (2005)
Crop Coefficients

Mid-cycle Kc Critical
$K_{c,\text{max}} \quad \text{Climate Correction}$

\[ K_{c,\text{max}} = K_{ct} + \left[ 0.04(u_2 - 2) - 0.004(RH_{\text{min}} - 45) \right] \left( \frac{h}{3} \right)^{0.3} \]

$K_{ct} = 1.20$ for alfalfa

$U_2$ - wind speed (m s$^{-1}$) at 2 m over grass

$RH_{\text{min}}$ - minimum daily relative humidity

$h$ - canopy height (m)

Allen et al. (1998) - FAO 56
Length of Stages

Hunsaker, D.J., Pinter, P.J., Jr., Cai, H. (2002)
$K_c$ Comparison

Mean basal $K_c$ values from 3 lysimeters and 8 cutting cycles

Hunsaker, D.J., Pinter, P.J., Jr., Cai, H. (2002)
Annual Climate Corrected $K_c$ Curve for 8 cuttings of Alfalfa near Indio
Stress Coefficient

\[ K_s = 1 \quad K_s = 1 - \left( \frac{D_r - RAW}{TAW - RAW} \right) \]
Water Table Contribution

\[ Q_m = 4.65 e^{-0.083 z_m} \]

for \( z_m \) (cm) and \( Q_m \) (cm/day)

RAGAB and AMER (1986)
Alfalfa schedule near Indio, California with 8 cuttings, a water table at 20 inches below the root zone, and flexible dates and application amounts.
Alfalfa schedule near Indio, California with 8 cuttings, a water table at 20 inches below the root zone, irrigations 5 days following cutting and 10 days prior to cutting, and variable application amounts.
Alfalfa schedule near Indio, California with 8 cuttings, a water table at 20 inches below the root zone, irrigations 5 days following cutting and 10 days prior to cutting, and fixed application amounts.
Alfalfa schedule near Indio, California with 8 cuttings, a water table at 20 inches below the root zone, irrigations 6 days following cutting and 10 days prior to cutting, fixed application amounts, and no cycle 5 irrigation.
Yield Estimation

\[
1 - \frac{Y_a}{Y_c} = K_y \left( 1 - \frac{CET_a}{CET_c} \right)
\]

\(K_y = 1.1\) yield function for alfalfa

\(Y_c \approx 1.0\) tons/acre = yield max

\(CET_a = \) cumulative \(ET_a\)
\(CET_c = \) cumulative \(ET_c\)
Flexible Dates & Amounts

Fixed Dates & Variable Amounts

Fixed Dates & Amounts

No Cycle 5 Irrigation
Conclusions

- ISA is based on use of ETo and climate corrected Kc values
- ISA accounts for water table contributions
- ISA adjusts ETa for water stress
- ISA estimates effects on yield
- ISA helps determine optimal schedules