Crop Water Demand, Use and Importance of Water Management in Forage Crops

Irrigation Management Workshop

Western Alfalfa and Forage Symposium, “Producing Forages in a Water-Challenged World”

Reno, NV, December 2, 2015

Dr. Howard Neibling, P.E.
Water Management Engineer
University of Idaho
What do we want the irrigation system to do??

• Supply water to meet crop needs (minimal stress) for best crop yield and quality
  – The right amount of water at the right time
  – Keep up (a system design issue)

• Match wetted depth to root extraction pattern (minimize deep percolation losses, but enhance development of a deep root zone)
Right amount of water at right time and be able to “keep up”

• Therefore, we need good information about daily crop water use
  – Seasonal crop water use pattern
  – Peak use
  – Variability form year to year
Timing of Crop ET and Critical Crop Stages for Magic Valley Conditions

- Winter Grain: Tillering, Boot - flower
- Spring Grain: Tillering, Boot - flower, Flowering, Tuber set, Pollination
- Dry Beans: Germination, Emergence & Early Growth, Early growth, Pollination
- Potatoes: New fall seedings
- Field Corn: Winter grain
- Sugar Beets: Spring grain
- Alfalfa: Winter grain

Date:
3/30, 4/13, 4/27, 5/11, 5/25, 6/8, 6/22, 7/6, 7/20, 8/3, 8/17, 8/31, 9/14, 9/28, 10/12, 10/26
How do you get crop water use (ET) information?

- Lysimeter data (measured using water balance)
- Remote Sensing (Metric, EC)
- Estimated use based on daily weather data (historical data for planning and current year data for scheduling)
  - CIMIS
  - AgriMet
  - ...

Alfalfa Lysimeter Trial, 2014  Davis, CA

Actual ET, in/d

CIMIS PM ETo

Actual ET"
What is the relationship between crop water use and alfalfa production?
Figure 13. Yield versus Et for Alfalfa at Kimberly, Idaho - 1982.

The equation for the linear relationship is:

\[ Y = 0.8 + 0.029(ET) \text{ (mm)} \]

with a correlation coefficient of \( r^2 = 0.95 \).
Figure 8. Yield versus ET for Alfalfa at Kaysville, Utah - 1980.

\[ Y = -1.8 + 0.009(ET) \text{ (mm)} \quad r^2 = 0.69 \]
Figure 9. Yield versus ET for Alfalfa at Logan, Utah - 1980.
Figure 10. Yield versus ET for Alfalfa at Kaysville, Utah - 1981.
Figure 11. Yield versus ET for Alfalfa at Logan, Utah - 1981.
Irrigated Alfalfa, Yuma Mesa, AZ
Superstition fine sand

Yield, T/ac vs. Percent of Optimum Water

- ▲ Optimum N
- + 53/33/53% N
- × 147/167/147 % N
What is the relationship between crop water use and alfalfa production?

- Linear increase in yield with increasing water use to estimated peak ET, then drops off
- Slope of line changes with location
- At Kimberly, what is an inch of water worth?
  - Early season: about 510 lb
  - Remaining season: 400 lb
Adequate Early-season Water Is Important for Alfalfa Production!

What is an inch of water worth?
- Early season: about 510 lb
- Remaining season: 400 lb
Alfalfa

- Yield proportional to water added (5 inches per ton of hay)
- Irrigate young stands frequently to develop adequate root depth
- Roots will develop to 4 ft + if soil and irrigation management allow
- Irrigate right after harvest to enhance re-growth
- Better to stretch water over more acres than to fully irrigate limited acres
Pivot design should accommodate some uncertainty in peak ET

2007 and Average Kimberly Alfalfa AGRIMET ET

Estimated ET, inches/day


Typical pivot rate

2007 alfalfa 92-07 avg alfalfa
Yearly water use patterns are quite variable, so irrigating according to “average” values may not give the best results.
Rexburg Alfalfa

AgriMet Estimate ET, in/day

6 gpm/ac

- 92-07 average (29 in)
- 2007 (38 in)
- 1992 (25 in)
Pasture: Rexburg, ID  Elev. = 4875 ft

AgriMet Estimated ET, In/d

seasonal water use, inches  31  20  25

max (07)  min(93)  92-07 avg
Pasture: Twin Falls, ID  Elev. = 3920 ft

Pasture: Madras, OR  Elev. = 2440 ft

Pasture: Omak, WA  Elev. = 1235 ft

Moderate Elevation Sites
High Elevation Sites
Mean Alfalfa ET - Kimberly

Max. Set-Move rate at 9 gpm/ac
Max. center pivot rate at 6.9 gpm/ac
The End -- Questions ??
Alfalfa Irrigation Considerations

• Alfalfa is deep rooted with nearly uniform water extraction with depth
• Pivots need to be run as slow as possible without runoff to encourage deeper roots
• Set-move systems
  – Need to return fast enough so that crops are not stressed between sets
  – Need to apply only water to re-fill root zone
• Seasonally high water table
  – Limits root depth
  – therefore each irrigation must be smaller and irrigations should occur more often to avoid leaching & stress
Pivot design should accommodate some uncertainty in peak ET