University of California
Agriculture and Natural Resources

HOW MUCH WATER DOES ALFALFA NEED?

Kearney Alfalfa and Forage Field Day
September 18, 2015 - Parlier, CA

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PRESENTATION OUTLINE

1) What is ET?

2) How much water does Alfalfa really need over the season?

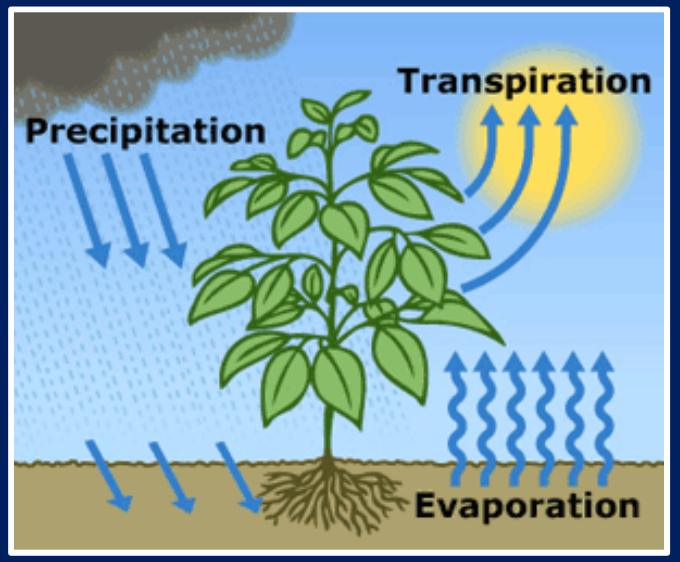
3) What other information we need to schedule irrigation??

WHAT IS ET?

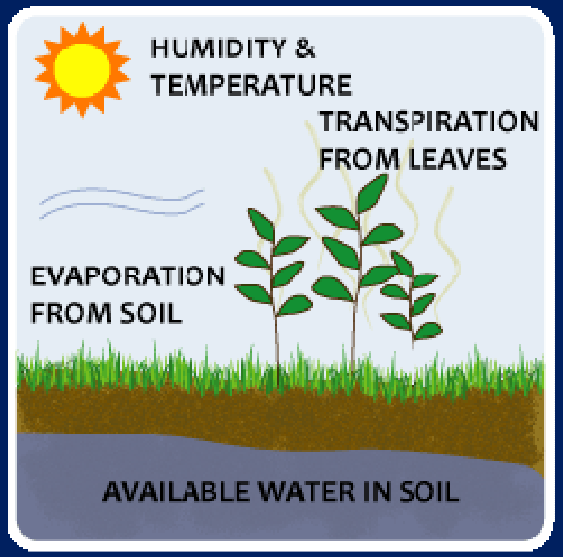

A STEVEN SPIELBERG FILM
E.T.
THE EXTRA-TERRESTRIAL


E.T.
THE EXTRA-TERRESTRIAL
THE 20TH ANNIVERSARY

REAL ET?



Evapotranspiration or ET is the total amount of water lost through evaporation in the soil and transpiration ("breathing") of the plants.



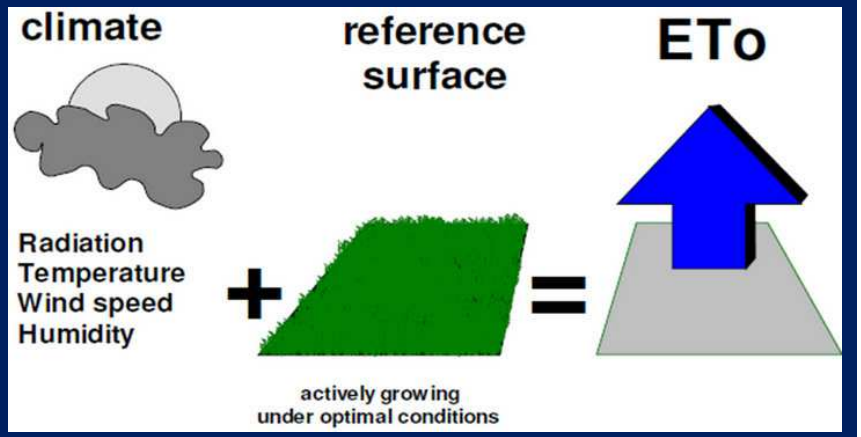
↑ ET =>

- ✓ Crop stage ↑
- ✓ Solar Radiation ↑
- ✓ Air Temperature ↑
- ✓ Relative Humidity ↓
- ✓ Wind Speed ↑
- ✓ Soil Moisture ↑

ETc vs. ETo

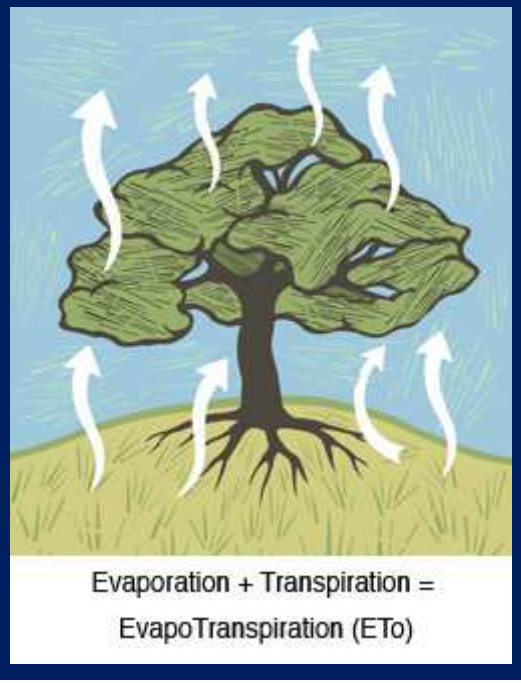
ETo or **Reference Evapotranspiration** is the water lost from:

- ✓ an extensive surface of green grass
- ✓ well-watered
- ✓ free of water stress and diseases
- ✓ with uniform height (4.7 in.)
- ✓ actively growing
- ✓ completely shading the ground.

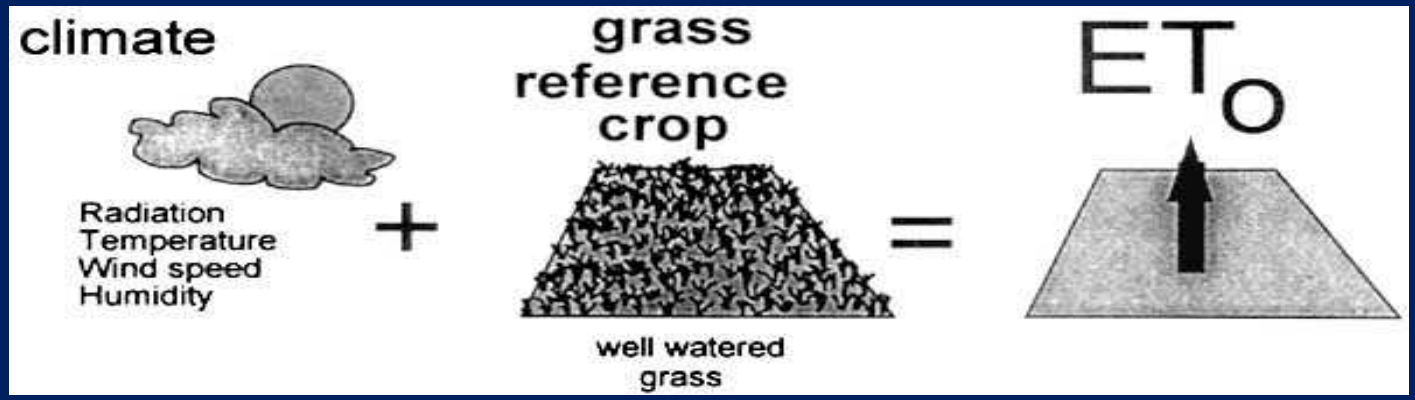


ETc or **Crop Evapotranspiration** is the amount of water lost from:

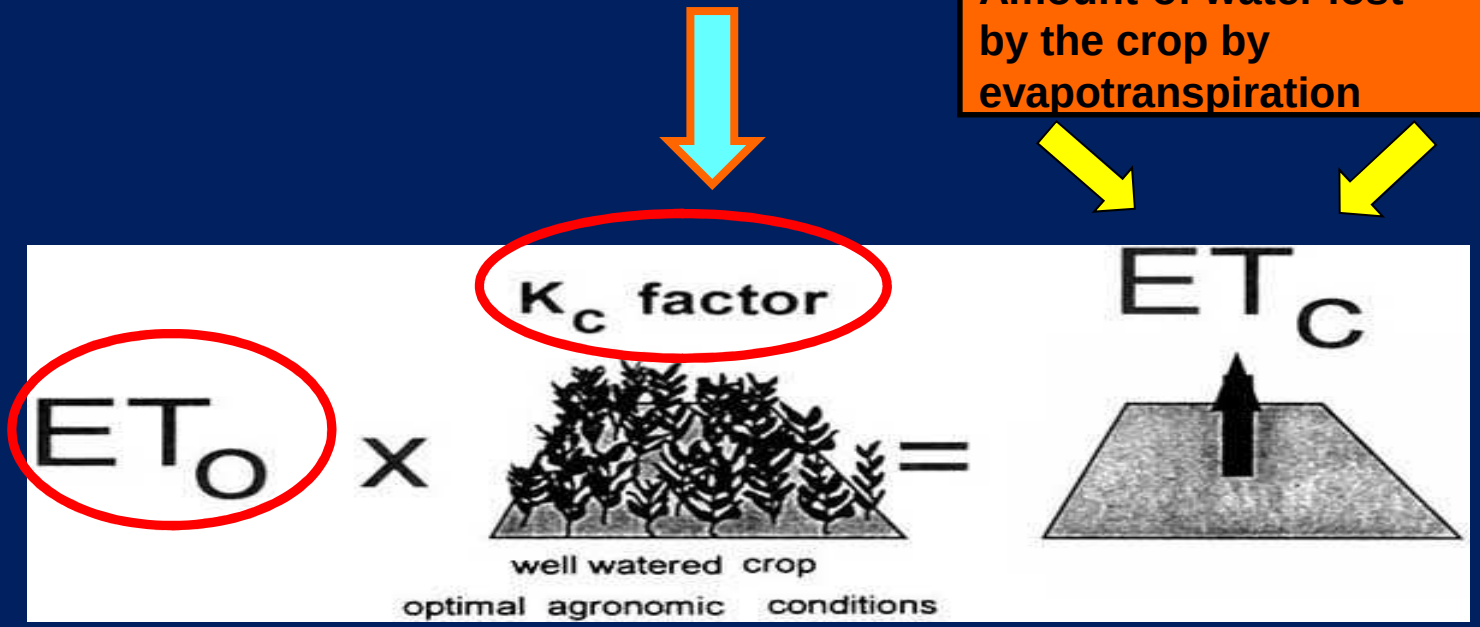
- ✓ a disease-free, well-fertilized crop
- ✓ grown in large fields,
- ✓ under optimum soil water conditions,
- ✓ achieving full production under the given climatic conditions.



For scheduling irrigation we need to estimate how much water has been used by the crop within a defined period of time



Amount of water lost by the crop by evapotranspiration

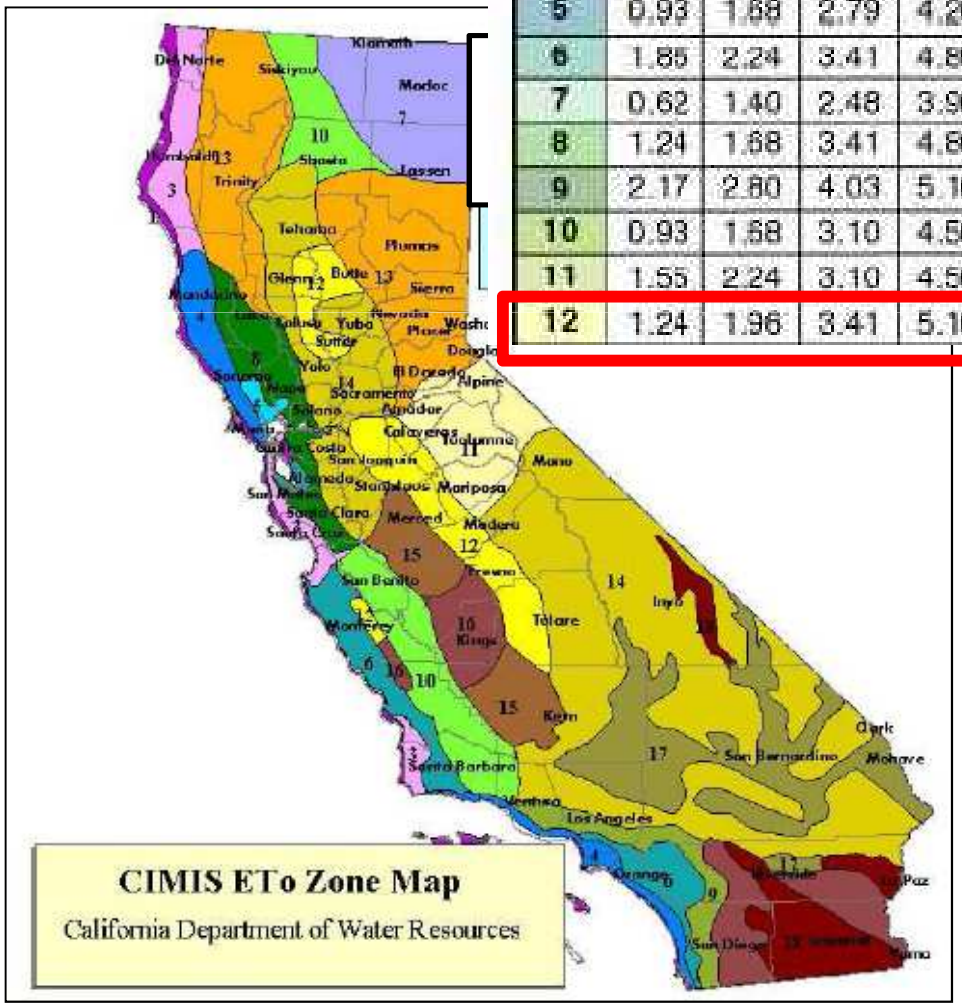


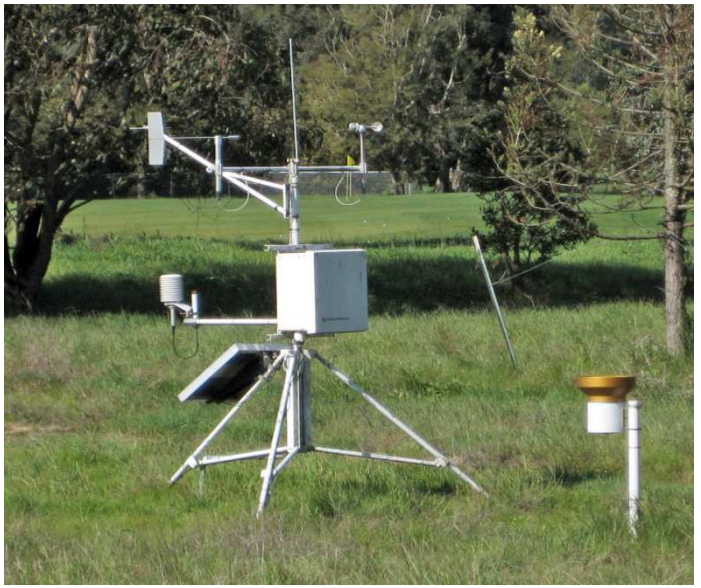
Historical ET_o average estimates: http://wwwcimis.water.ca.gov/cimis

CIMIS

Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)

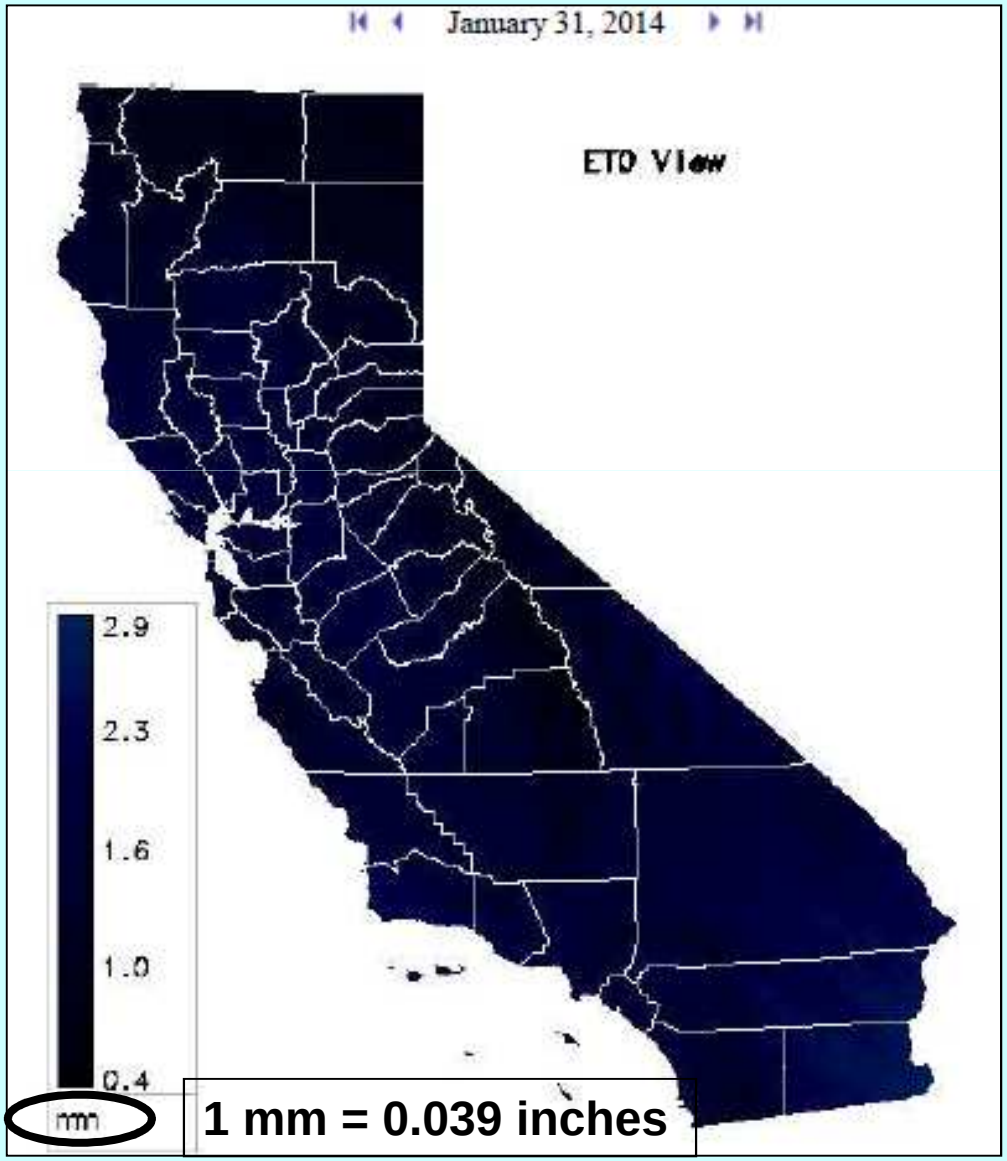
Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	33.0
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.85	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.4
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.0
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.3





Real-time ET_o data from Spatial CIMIS

http://wwwcimis.water.ca.gov/cimis/cimiSatSpatialCimis.jsp



HISTORICAL AVERAGE VALUES OF ETo (in./day)

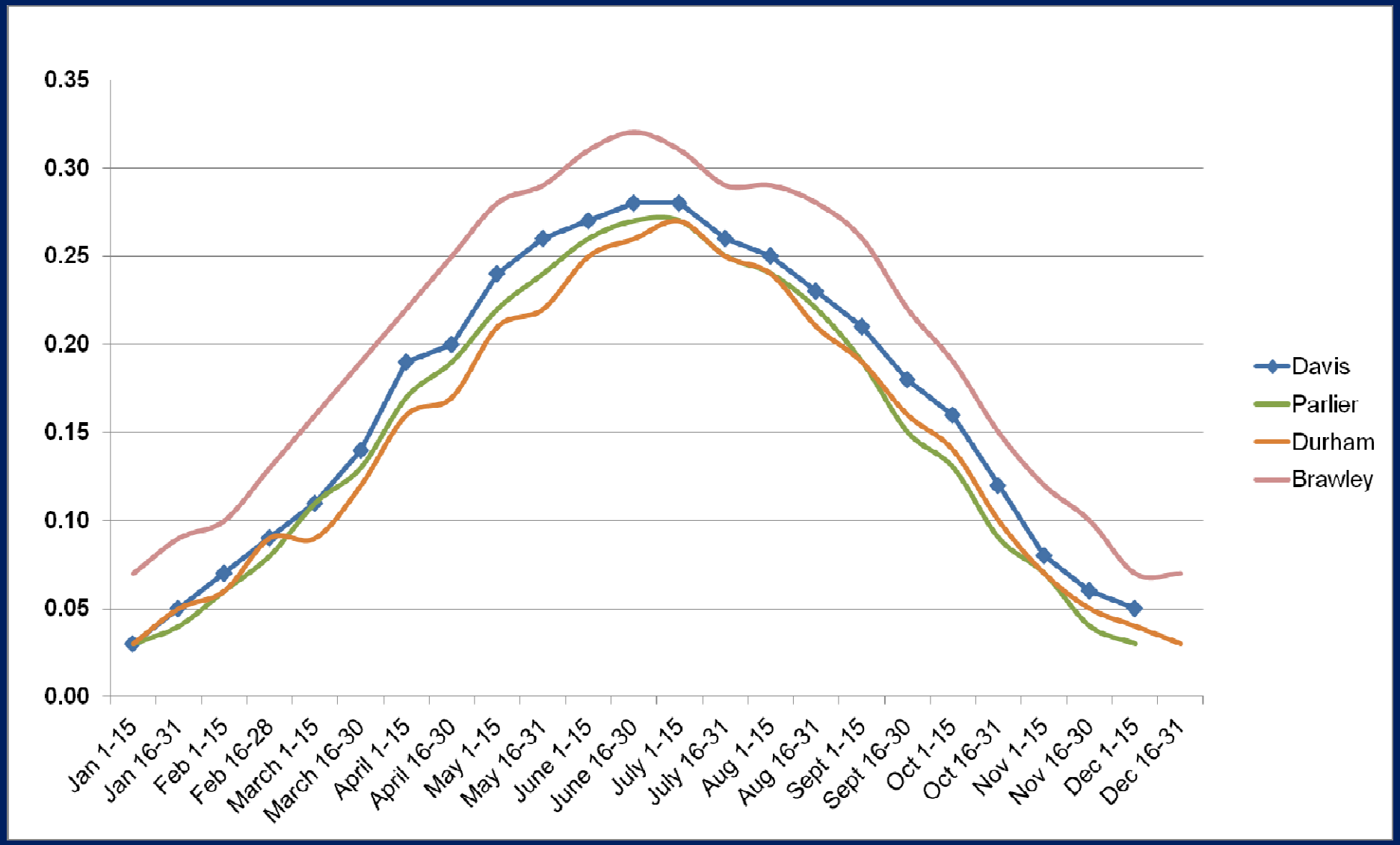
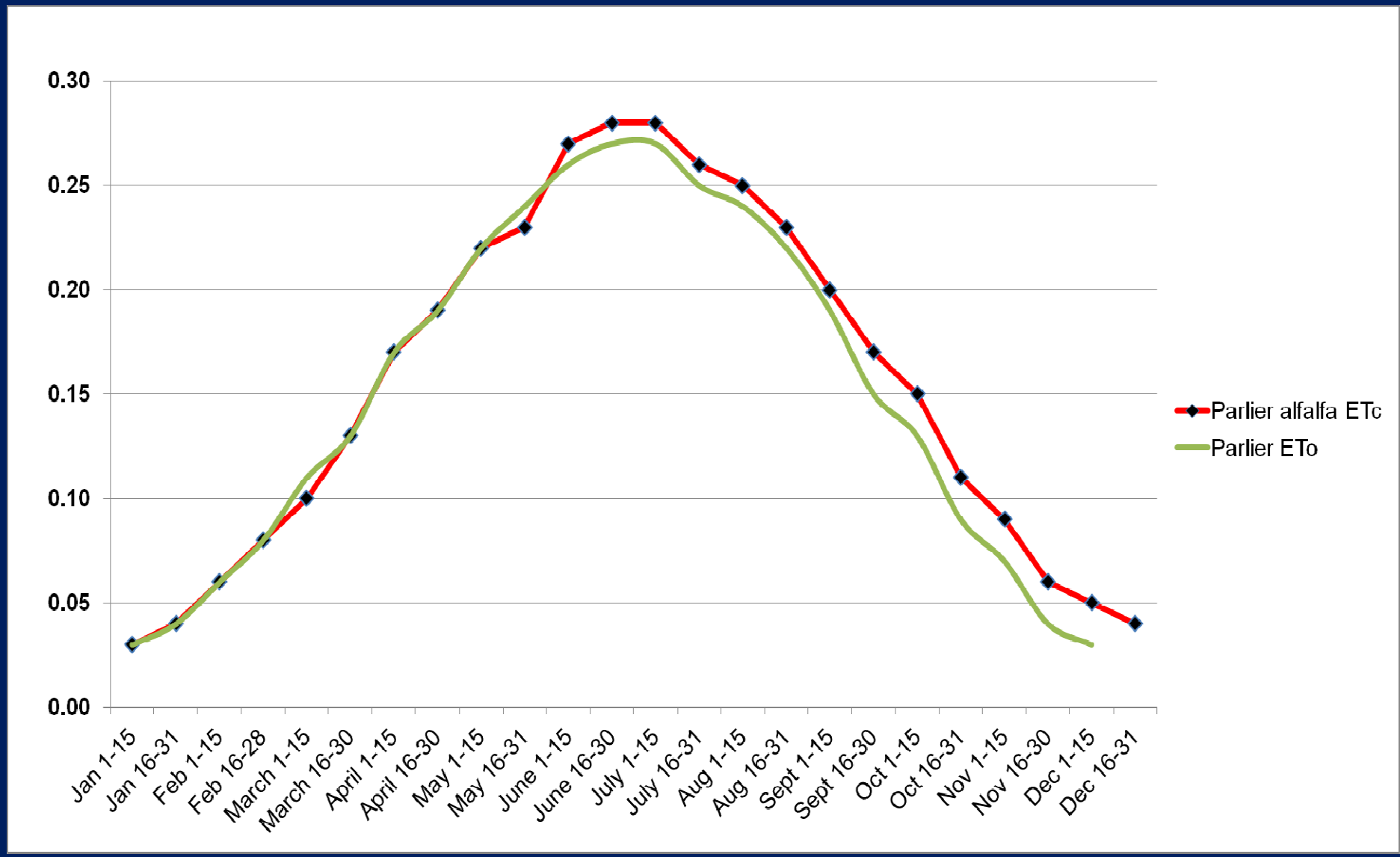


Table 2. Historical alfalfa crop evapotranspiration (inches per day).

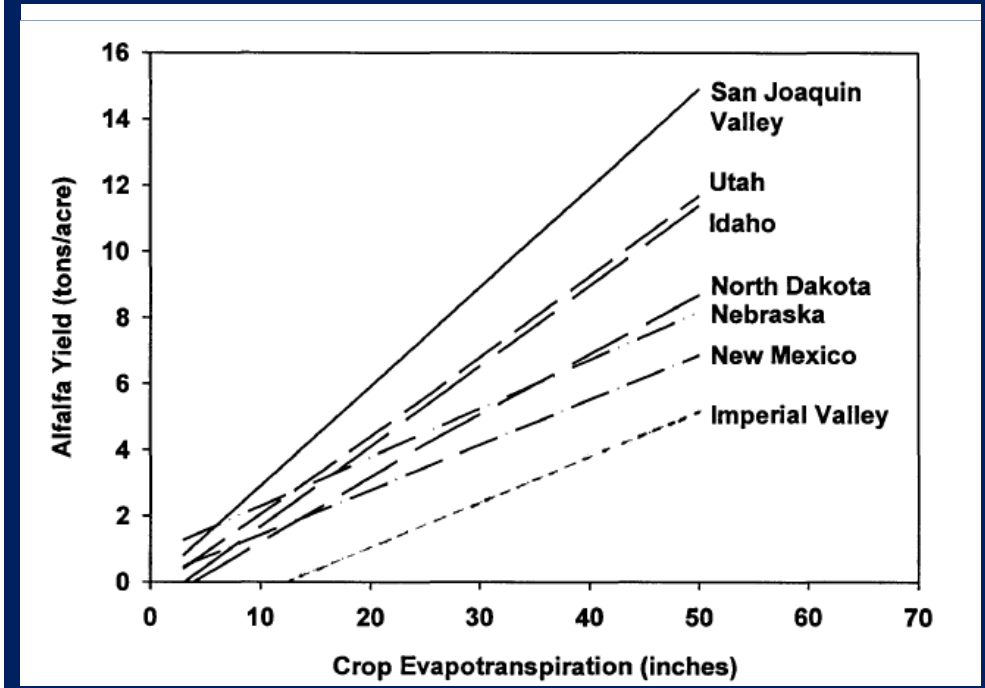
		Shafter	Five Points	Parlier	Davis	Nicolaus	Durham	McArthur	Brawley
Jan	1-15	0.03	0.04	0.03	0.03	0.03	0.03	0.02	0.07
	16-31	0.05	0.05	0.04	0.05	0.04	0.05	0.03	0.09
Feb	1-15	0.07	0.06	0.06	0.06	0.06	0.06	0.04	0.10
	16-30	0.09	0.09	0.08	0.09	0.09	0.09	0.07	0.13
Mar	1-15	0.11	0.11	0.10	0.09	0.09	0.09	0.08	0.16
	16-31	0.14	0.15	0.13	0.14	0.12	0.12	0.11	0.19
Apr	1-15	0.19	0.20	0.17	0.18	0.15	0.16	0.14	0.22
	16-30	0.20	0.22	0.19	0.20	0.18	0.17	0.14	0.25
May	1-15	0.24	0.26	0.22	0.23	0.21	0.21	0.18	0.28
	16-31	0.26	0.27	0.24	0.24	0.21	0.22	0.19	0.29
Jun	1-15	0.27	0.29	0.26	0.28	0.24	0.25	0.22	0.31
	16-30	0.28	0.30	0.27	0.29	0.26	0.26	0.25	0.32
Jul	1-15	0.28	0.30	0.27	0.29	0.26	0.27	0.27	0.31
	16-31	0.26	0.28	0.25	0.27	0.25	0.25	0.25	0.29
Aug	1-15	0.25	0.28	0.24	0.26	0.24	0.24	0.25	0.29
	16-31	0.23	0.25	0.22	0.24	0.21	0.21	0.22	0.28
Sep	1-15	0.21	0.23	0.19	0.21	0.19	0.19	0.18	0.26
	16-30	0.18	0.20	0.15	0.18	0.16	0.16	0.14	0.22
Oct	1-15	0.16	0.17	0.13	0.16	0.13	0.14	0.12	0.19
	16-31	0.12	0.13	0.09	0.12	0.09	0.10	0.08	0.15
Nov	1-15	0.08	0.10	0.07	0.09	0.07	0.07	0.05	0.12
	16-30	0.06	0.07	0.04	0.06	0.05	0.05	0.03	0.10
Dec	1-15	0.05	0.05	0.03	0.05	0.03	0.04	0.02	0.07
	16-31	0.03	0.03	0.02	0.04	0.04	0.03	0.02	0.07

HISTORICAL AVERAGE ALFALFA ETc PARLIER (in./day)

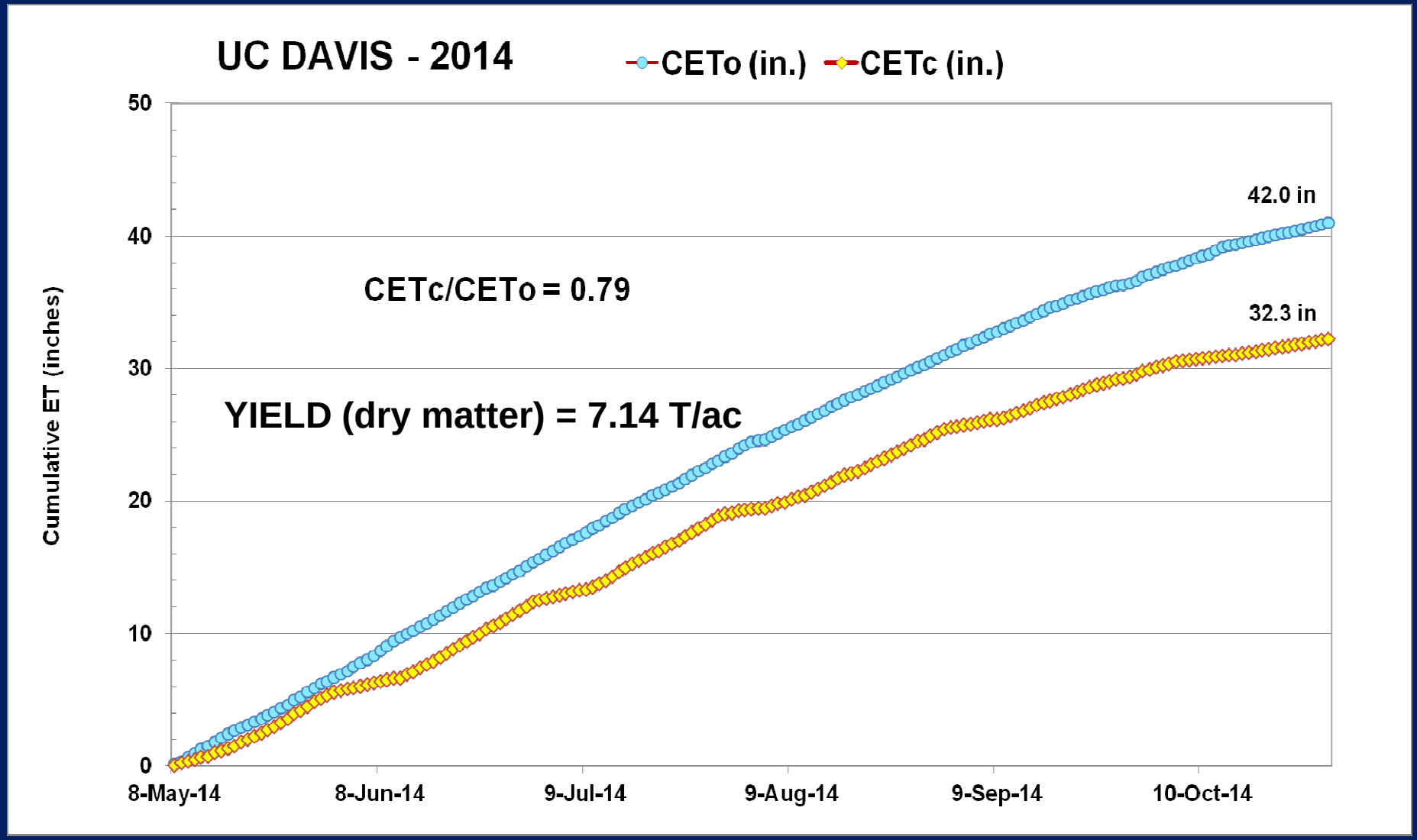


HOW MUCH WATER DOES ALFALFA NEED ON AVERAGE OVER THE SEASON?

Site	Seasonal ETc (inches)
Imperial Valley	58-62
Sacramento Valley	49-52
Central Valley	51-54
Intermountain	35-38



DATA FROM THE LYSIMETER STUDY AT UC DAVIS 2014



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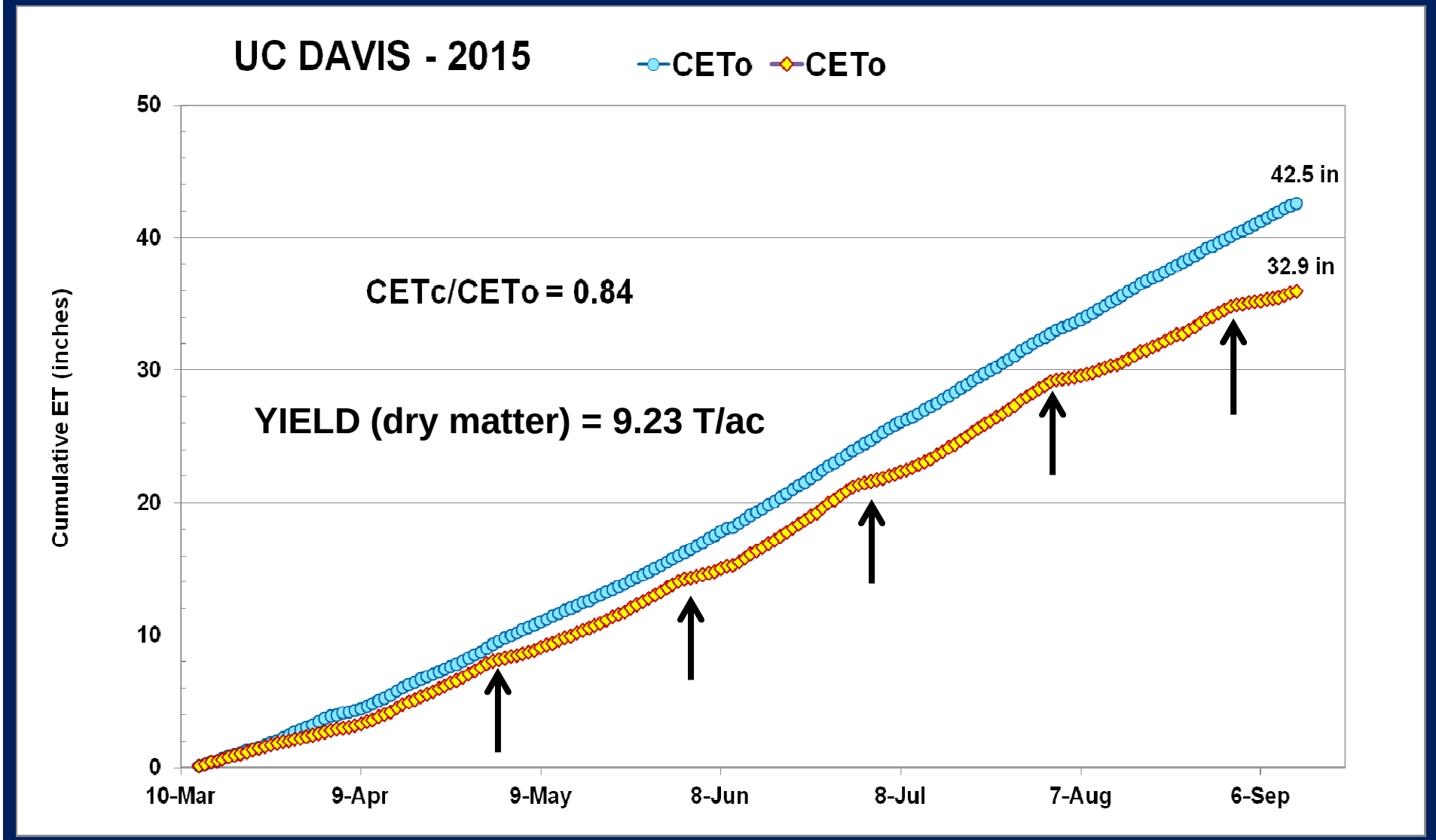
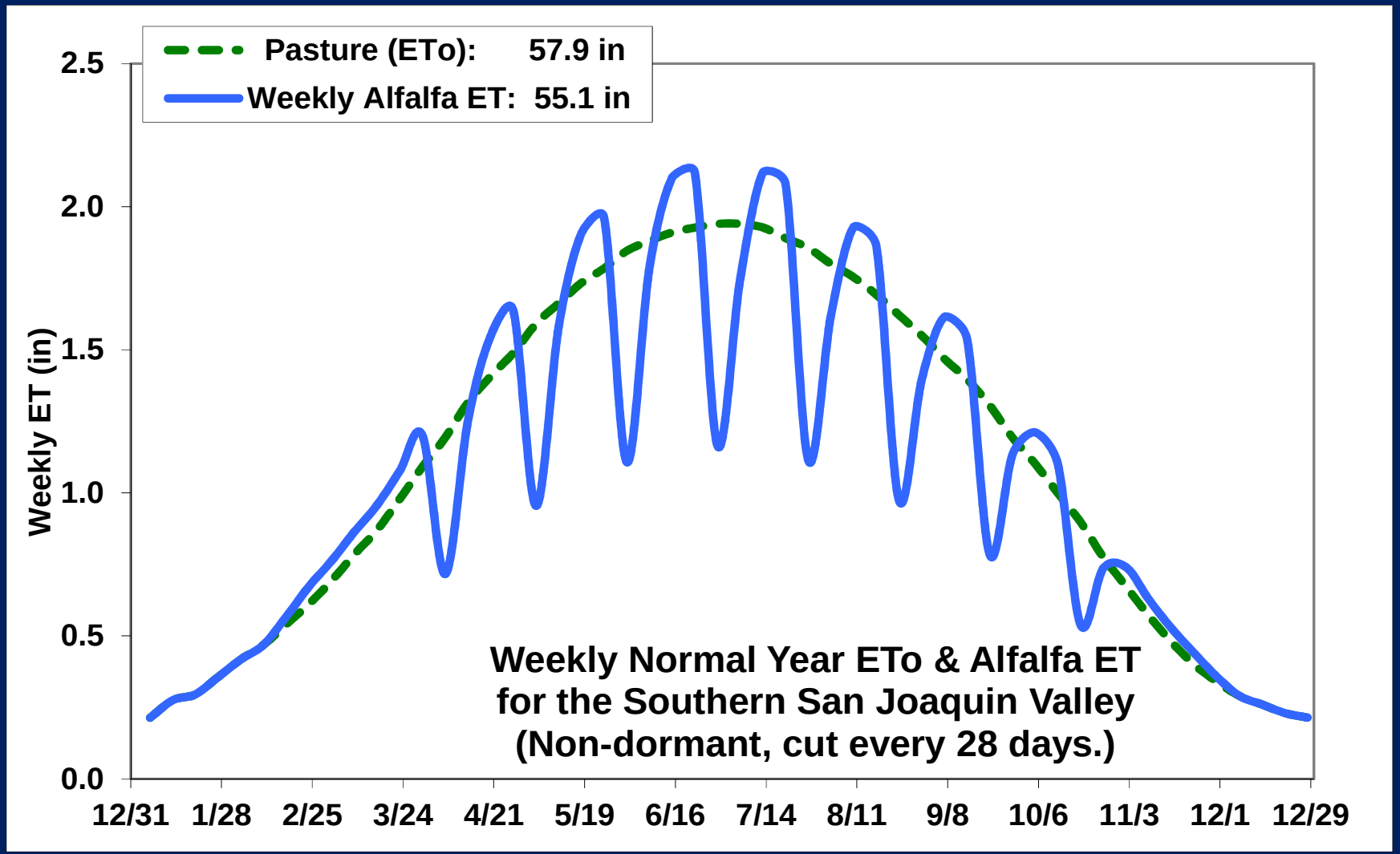
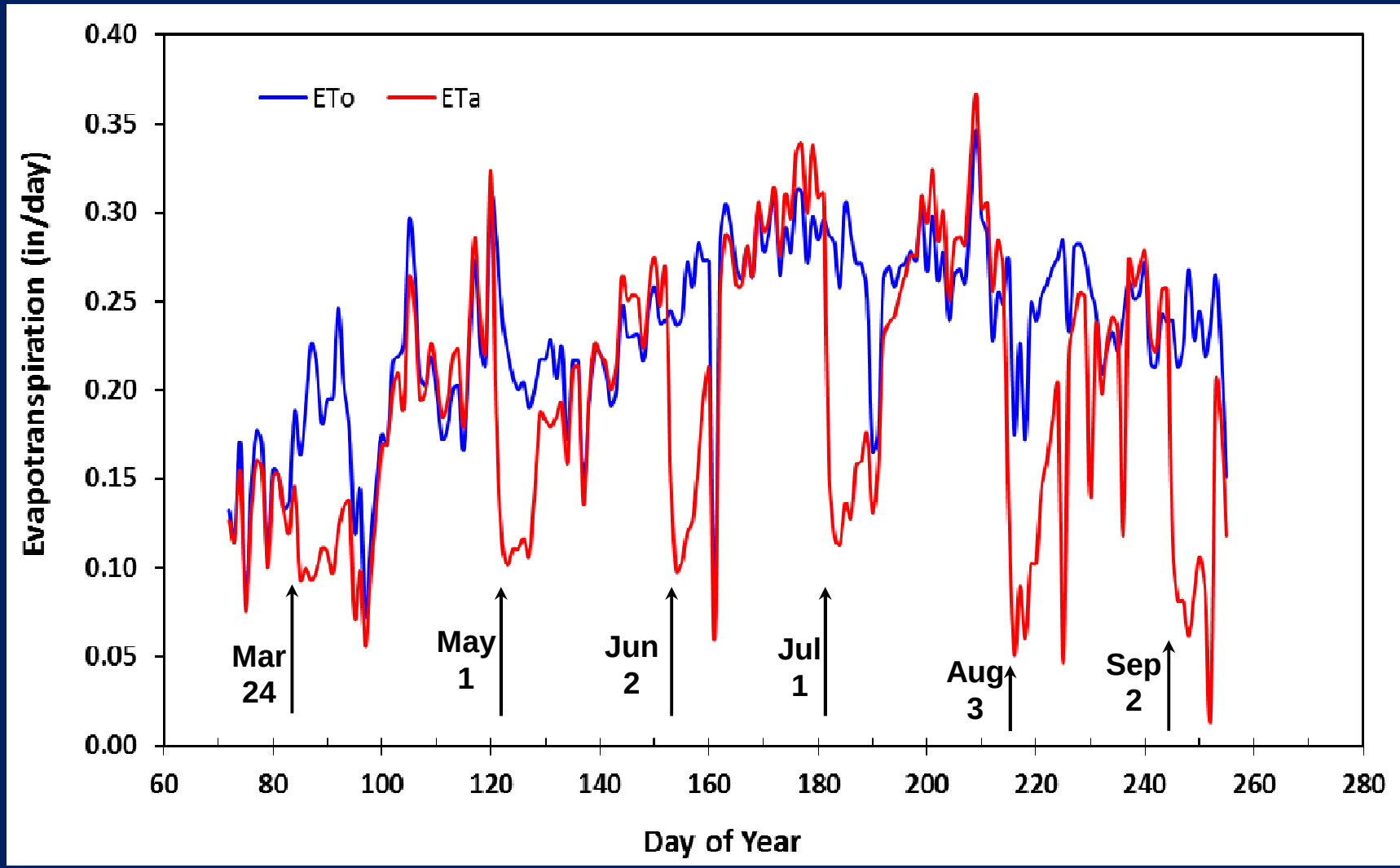


ETc vs. ETo for the S.J.V.

(Sanden et al., 2012)



DAVIS 2015


ETo
ETa
Evapotranspiration (in/day)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
60
80
100
120
140
160
180
200
220
240
260
280
Day of Year
Mar 24
May 1
Jun 2
Jul 1
Aug 3
Sep 2

AVERAGED VALUES OF WATER USE (ETc)

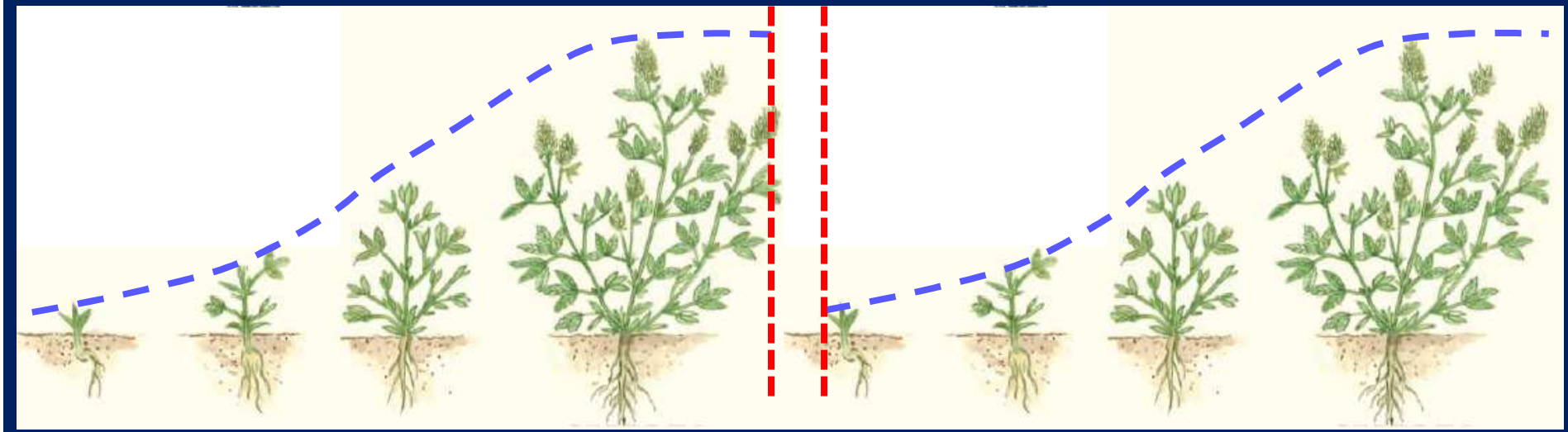
Seasonal Crop Coefficient:

K_c = 0.79 – 0.85 (averaged over the entire crop season)

Within-cycle Crop Coefficient:

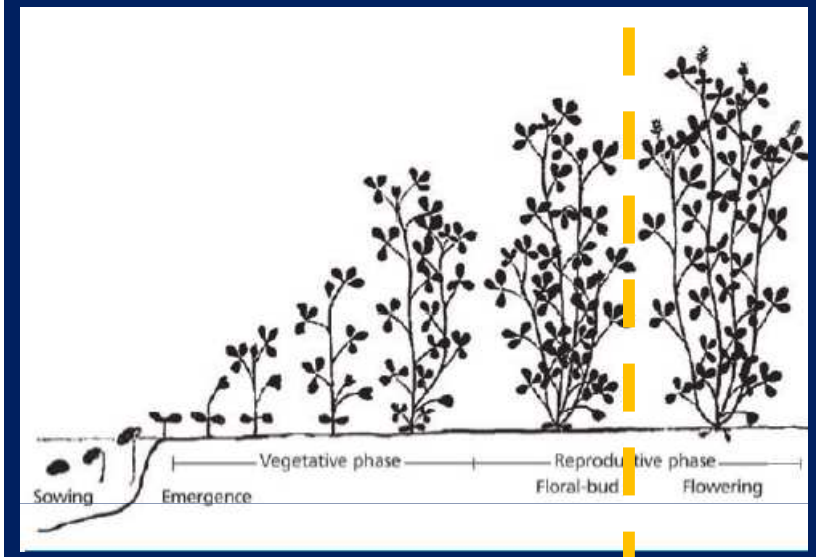
$K_c \approx$ 0.35 - 0.40 after cutting until irrigation

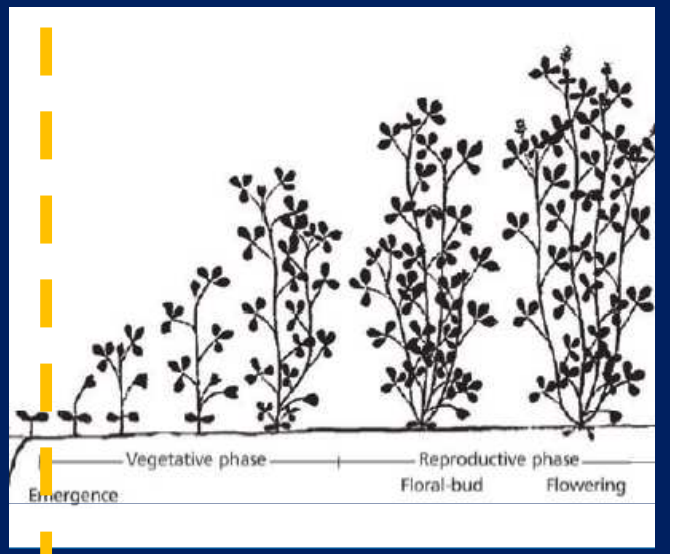
$K_c \approx$ 1.05 - 1.10 from 2-3 days after irrigation till the next cutting



IRRIGATION MANAGEMENT IN ALFALFA IS CHALLENGING!

NO IRRIGATION





6-20 DAYS

✓ET-based scheduling is complicated by the periodic cutting & re-growth cycles

✓Irrigations are cut back a few days prior to cutting, and during hay curing

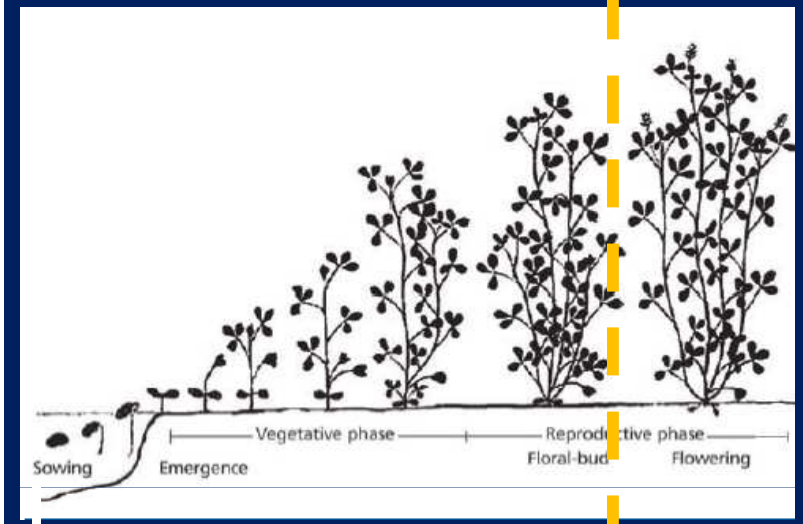
✓**At least 6- to 20-day periods during which fields cannot be irrigated**

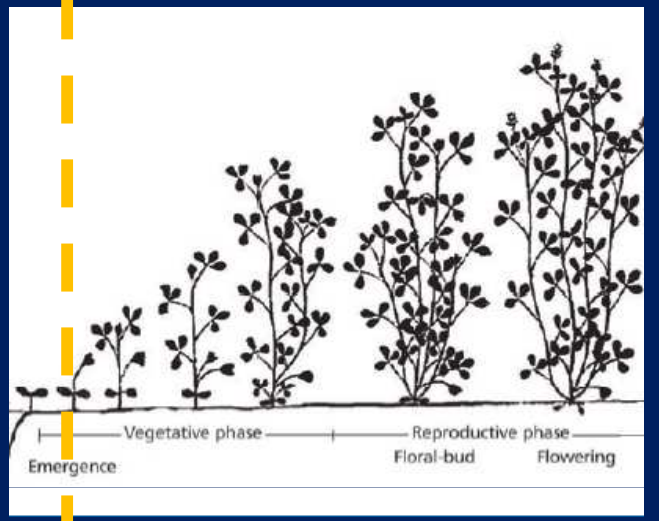
✓**Irrigation decisions are driven and constrained by the cutting schedule**

WHAT HAPPENS DOWN THERE IN THE SOIL?

Water stress (deficit or excess)?
How much, and for how long?

Is there any deep soil water storage (buffer)?





F.C.

Irrigation Threshold

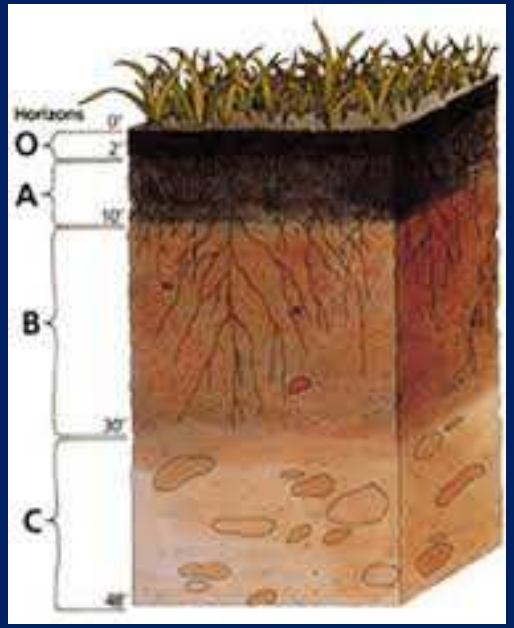
Water stress Threshold

W.P.

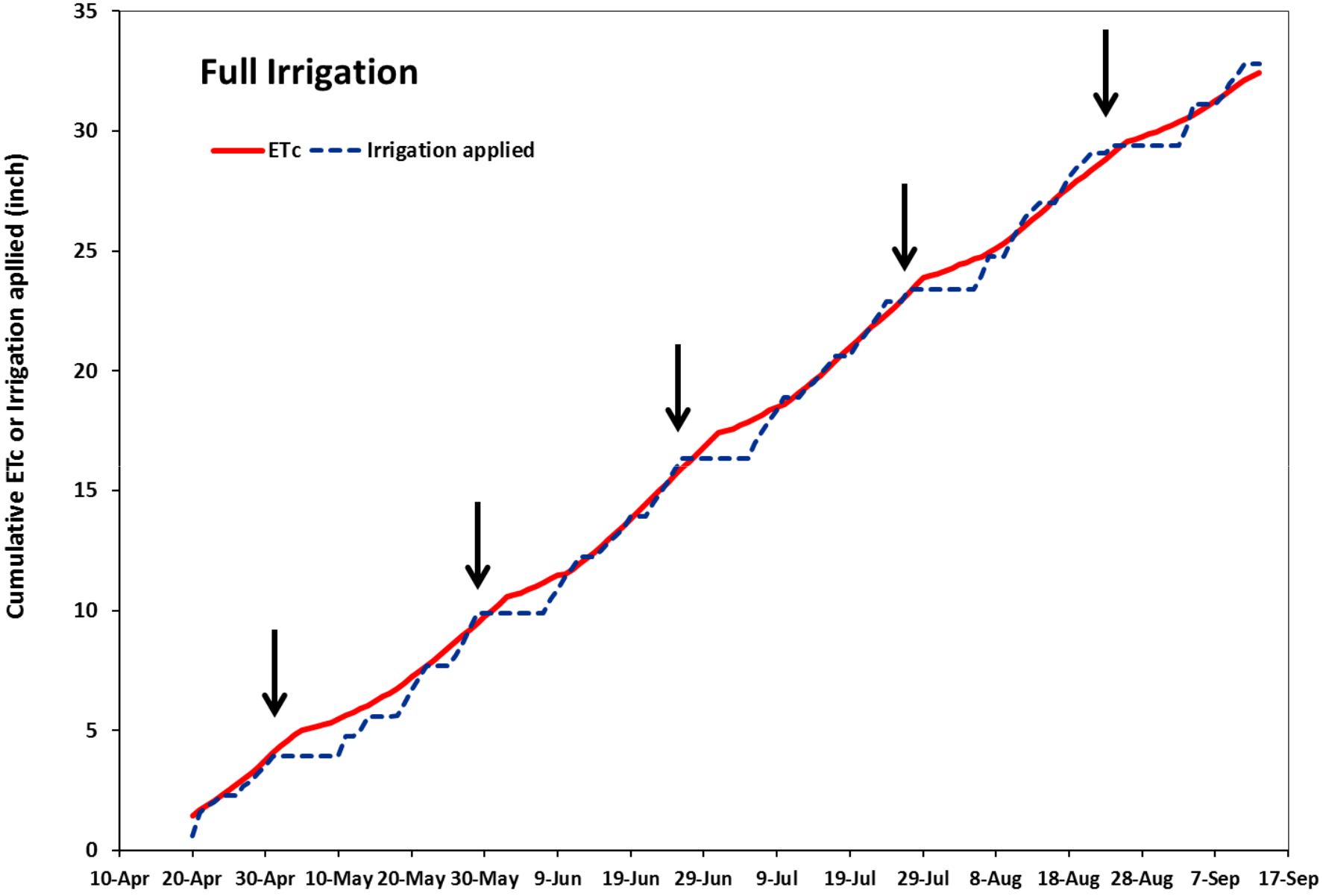
6-20 DAYS

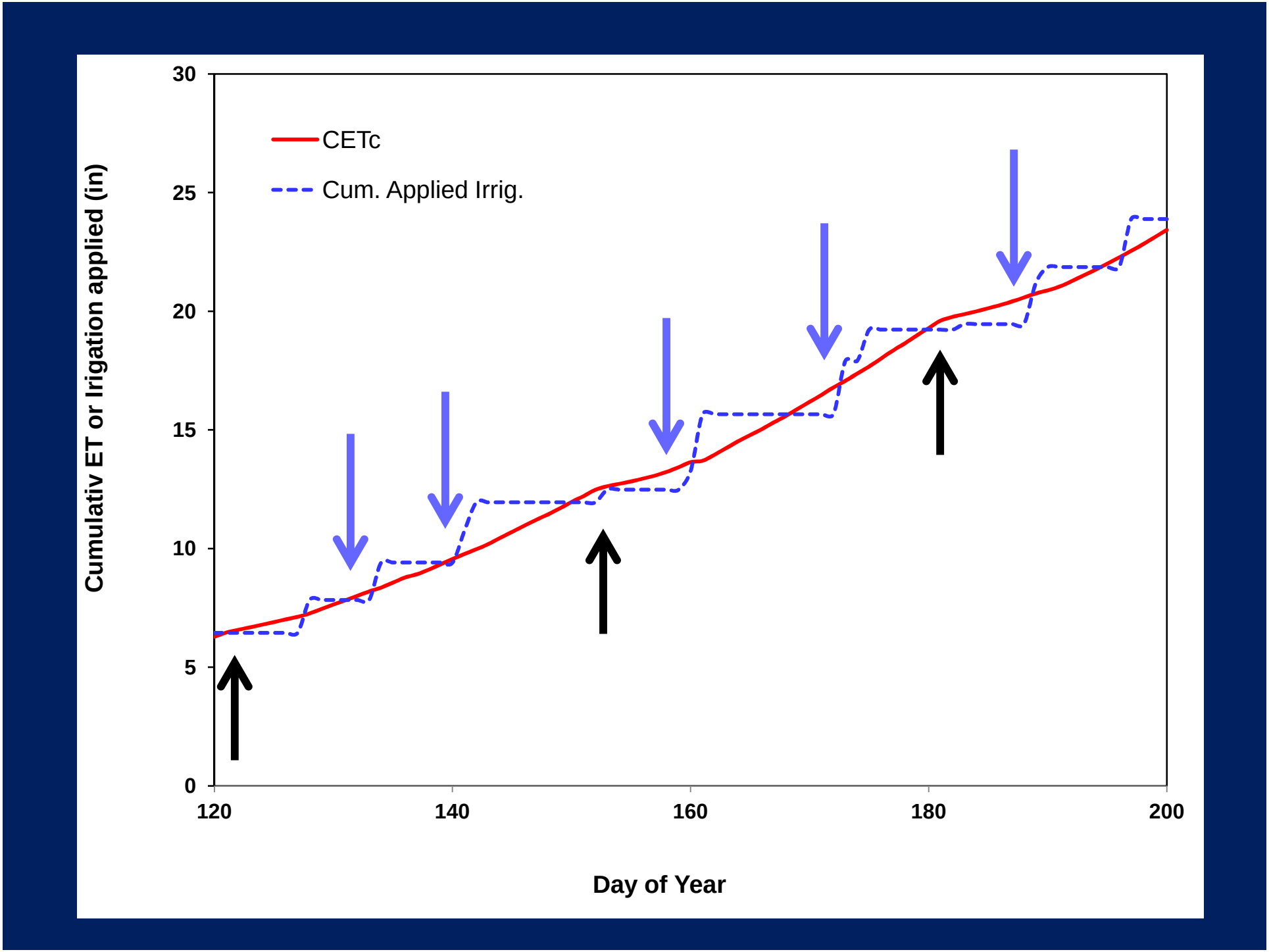
DAYS

WHAT OTHER INFORMATION WE NEED TO IRRIGATE ALFALFA PROPERLY?



Soil Texture	Water Holding Capacity (inches/ft)	Average Root Depth (ft)	Total available soil moisture storage (inches)	50% of Available Soil Moisture (inches)
Sand	0.7	5.0	3.5	1.75
Loamy sand	1.1	5.0	5.5	2.75
Sandy loam	1.4	5.0	7.0	3.50
Loam	1.8	5.0	9.0	4.50
Silt loam	1.8	5.0	9.0	4.50
Sandy clay loam	1.3	5.0	6.5	3.25
Sandy clay	1.6	5.0	8.0	4.00
Clay loam	1.7	5.0	8.5	4.25
Silty clay loam	1.9	5.0	9.5	4.75
Silty clay	2.5	5.0	12.5	6.25
Clay loam	2.2	5.0	11.0	5.50

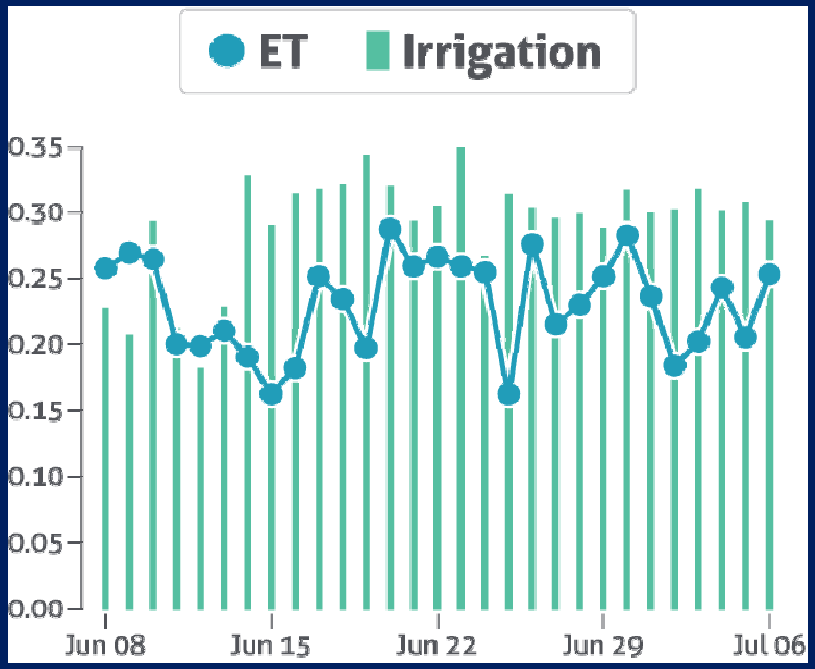

Full Irrigation
ETc
Irrigation applied
Cumulative ETc or Irrigation apllied (inch)
0
5
10
15
20
25
30
35
10-Apr
20-Apr
30-Apr
10-May
20-May
30-May
9-Jun
19-Jun
29-Jun
9-Jul
19-Jul
29-Jul
8-Aug
18-Aug
28-Aug
7-Sep
17-Sep

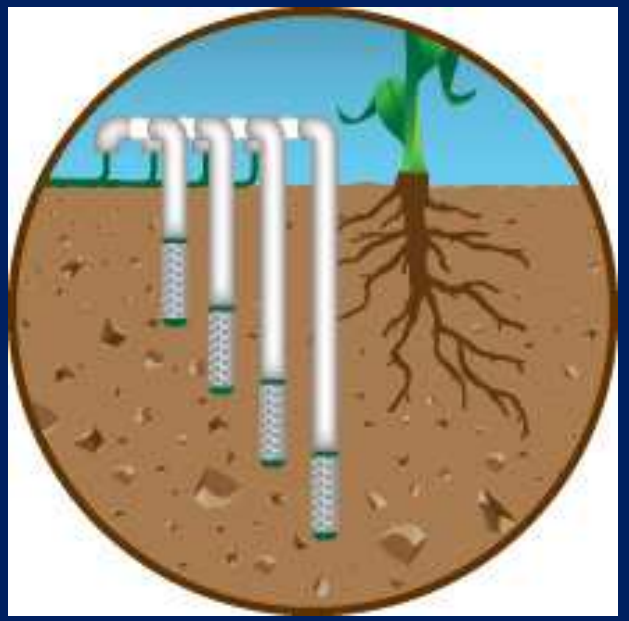

CETc
Cum. Applied Irrig.
Cumulativ ET or Irigation applied (in)
Day of Year
0
5
10
15
20
25
30
120
140
160
180
200

DOY	CETc	C Appl. Irrig.
122	6.58	6.44
123	6.68	6.44
124	6.79	6.44
125	6.90	6.44
126	7.02	6.44
127	7.13	6.45
128	7.27	7.83
129	7.46	7.83
130	7.64	7.83
131	7.82	7.83
132	8.01	7.83
133	8.20	7.83
134	8.36	9.41
135	8.57	9.41
136	8.78	9.41
137	8.92	9.41
138	9.11	9.41
139	9.34	9.41
140	9.56	9.41
141	9.77	10.74
142	9.97	11.95
143	10.19	11.95
144	10.45	11.95
145	10.70	11.95
146	10.96	11.95
147	11.21	11.95
148	11.43	11.95
149	11.69	11.95
150	11.96	11.95
151	12.21	11.95
152	12.48	11.95
153	12.63	12.48

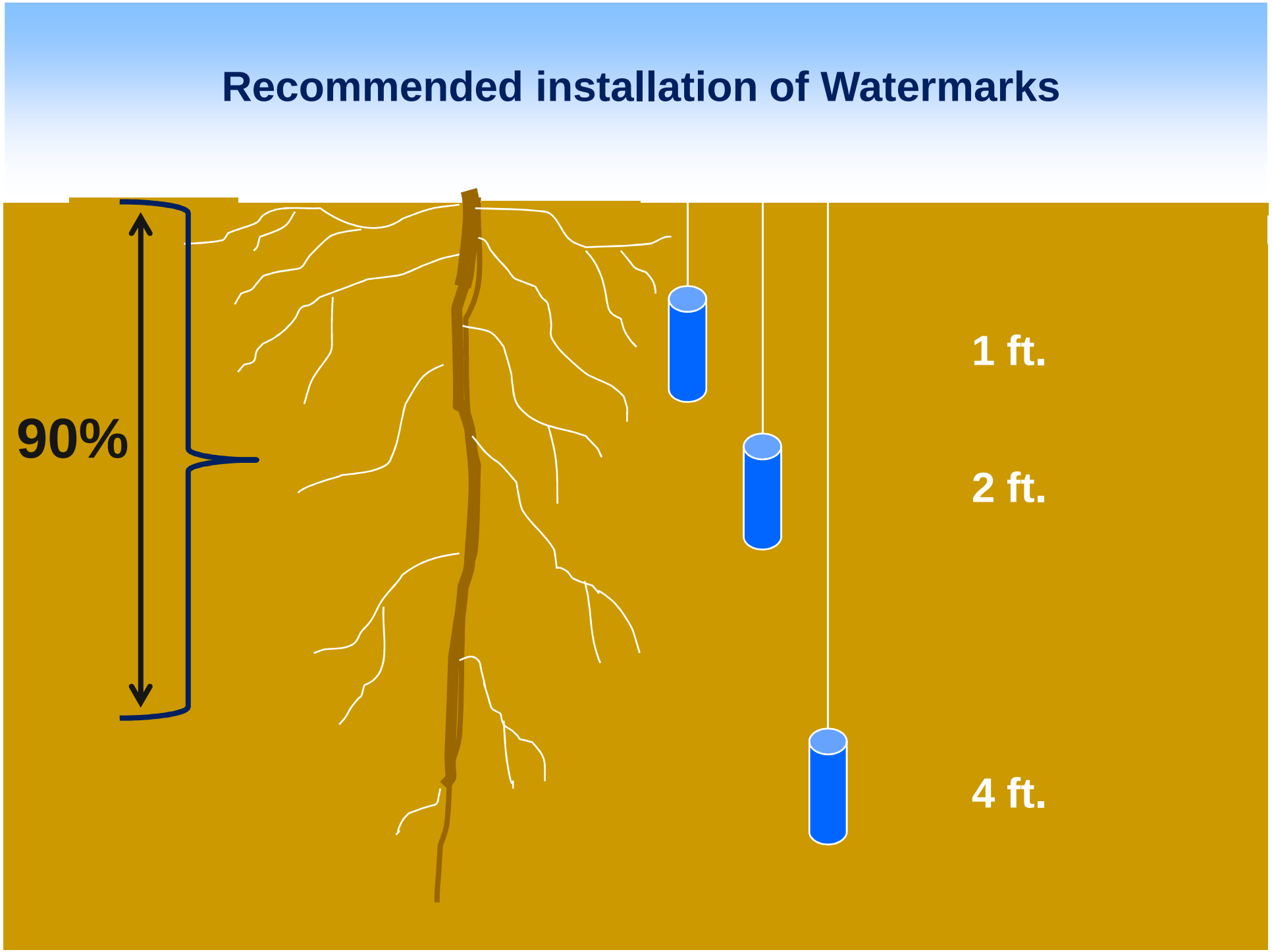
DOY	CETc	C Appl. Irrig.
154	12.73	12.48
155	12.83	12.48
156	12.95	12.48
157	13.08	12.48
158	13.23	12.48
159	13.43	12.48
160	13.64	13.27
161	13.70	15.66
162	13.95	15.66
163	14.24	15.66
164	14.52	15.66
165	14.78	15.66
166	15.04	15.66
167	15.32	15.66
168	15.59	15.66
169	15.89	15.66
170	16.18	15.66
171	16.48	15.66
172	16.79	15.66
173	17.07	17.91
174	17.38	17.91
175	17.67	19.22
176	18.01	19.22
177	18.35	19.22
178	18.65	19.22
179	18.99	19.22
180	19.29	19.22
181	19.60	19.22
182	19.76	19.22

THINGS THAT HELP IN THE FIELD

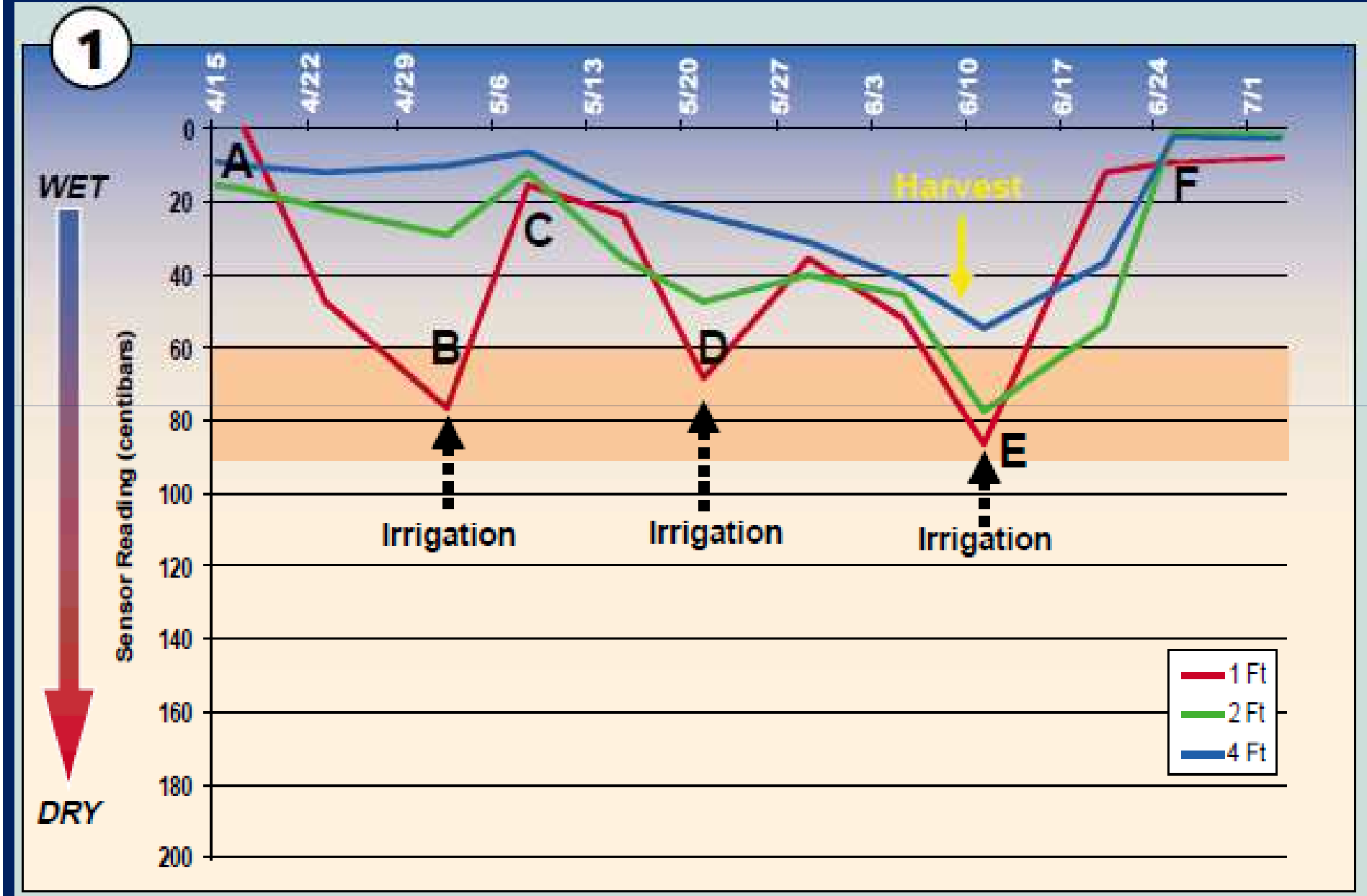




Recommended installation of Watermarks



Irrigation Scheduling Example: LOAMY SOIL



SUMMARY

ET-based irrigation scheduling in alfalfa is complicate due to cuttings and re-growth periods.

- ✓Requires understanding ET and making some basic calculations
- ✓ Knowing soil texture and soil water holding capacity
- ✓Create deep soil water reserve to avoid water deficit around harvest
- ✓Eventually monitoring soil moisture and ET is of great help

THANK YOU!