



## IRRIGATION TECH SEMINAR SERIES

### **AGENDA: WATERIGHT Web-Based Irrigation Scheduling • January 14, 2010**

- Work Shop Registration
- Welcome
- Introduction
- Overview of WATERIGHT
- Break
- Example
- Break
- More Examples

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Brought to you by:



**Irrigation Tech  
Seminar Series**

California State University, Fresno




# WATERIGHT - Web-Based Irrigation Scheduling

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**WATERIGHT**  
Online Irrigation Scheduling

Brought to you by:  
Dept. of Water Resources  
&  
Center for Irrigation Technology



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Today's discussion...

- Explanation of irrigation scheduling
- Introduction to WATERIGHT
- Demonstration of on-line scheduling
- Individual examples



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**Our Goal - Effective, Efficient Irrigations...**

- Effective irrigations do what I need – irrigate for a profitable crop.
- Efficient irrigations make the best use of an increasingly scarce and valuable resource – water.

They are the result of knowing WHEN, HOW MUCH, and HOW to irrigate.



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### “Irrigation Scheduling”...

- Irrigation Scheduling is a generic term for a number of techniques that aide the irrigator in determining WHEN and/or HOW MUCH to irrigate.
- Irrigation Scheduling can be a highly technical exercise or it can be as simple as you using a probe to feel a sample of the soil.




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### Irrigation Scheduling IS NOT...

- Irrigation scheduling says nothing about “HOW” to irrigate (remember the When, How Much, and How).
- “HOW” to irrigate is not knowing how to set a siphon tube or hook up a sprinkler booster.
- “HOW” to irrigate is being able to control the irrigation event to achieve good distribution uniformity with the right depth applied.

Knowing “how much” to apply does me no good if I can’t control the irrigation!




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### Irrigation Scheduling and “When”...

- “When” to irrigate is usually an agronomic question (Effectiveness). That is, do you want to irrigate to avoid stress or, as is the common situation with a crop like wine grapes, irrigate to induce a certain amount of stress?
- Irrigation Scheduling can help you control the stress on your crop.



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### Irrigation Scheduling and “How Much”

- “How much to irrigate” also depends on the situation:
  - Pre-irrigation to fill root zone
  - Normal irrigation to replace soil moisture deficit caused by ET
  - Normal irrigation plus leaching for salt control
  - Regulated Deficit Irrigation (maintain stress)
- Irrigation Scheduling can help you to know “How Much” to apply at each irrigation.



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### Irrigation Scheduling and “How Much”

- “How much...” might be described in terms of:
  - Net or gross depth of water to apply
  - Length of set (sprinklers)
  - Hours per day/week (high frequency irrigation systems)



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### Effective, Efficient Irrigations...

Every irrigation should have a purpose – put a specific amount of water, into a specific volume of soil, so as to maintain (or avoid) a desired amount of stress!



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## About WATERIGHT

- WATERIGHT - developed by the CIT with support from the Dept. of Water Resources.
- WATERIGHT is designed to be a multi-function, educational resource for irrigation water management.
- The site is designed for three audiences: homeowners, commercial turf growers, and agriculture.



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## WATERIGHT Education

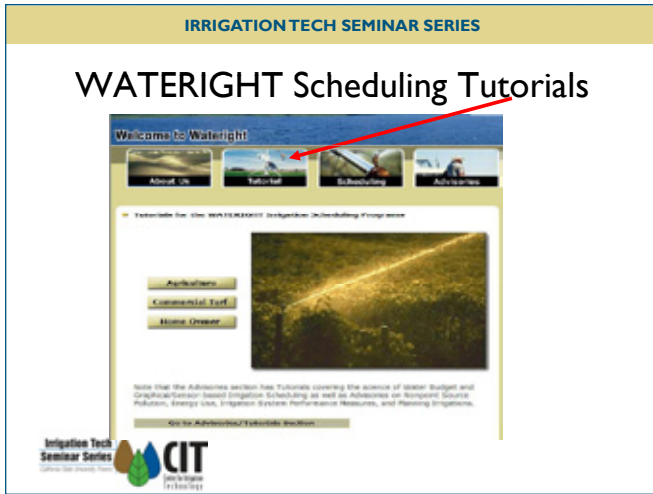


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## WATERIGHT

- Education – many tutorials and advisories
  - Water budget and graphical irrigation scheduling
  - DU vs IE – what they are, how they are related
  - Non-point source pollution – basic model, how you can reduce it
  - Planning an irrigation
  - Energy
  - Links to other sites





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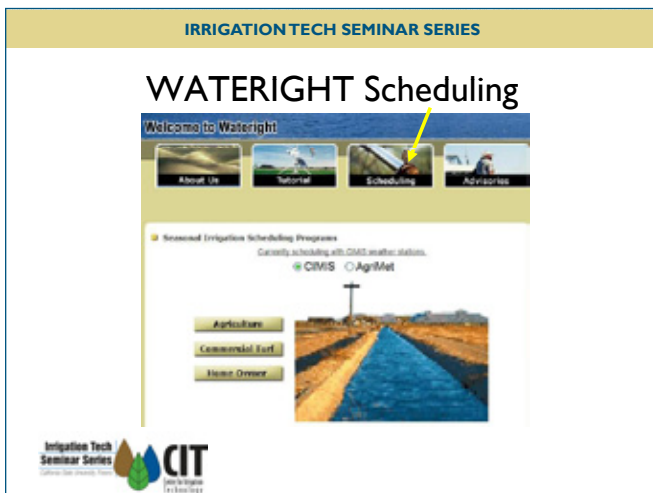

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## WATERIGHT

- **IMPORTANT NOTE!!**
  - The irrigation schedules produced by WATERIGHT are only estimates of plant / water requirements. They are based on long-term, average weather patterns and average crop coefficient curves.
  - Field verification by the user is absolutely necessary to ensure proper soil moisture levels and plant health throughout a growing season.



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WATERIGHT

- **Homeowners:**
  - For home owners who want to check their irrigation scheduling or improve upon them.
- **Commercial Turf Growers:**
  - Commercial business
  - Golf course managers
  - Parks and recreation
  - Landscape managers




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WATERIGHT

- **Agricultural Users:**
  - Farmers who want to do irrigation scheduling but know nothing about the subject - WATERIGHT is an educational resource!
  - Farmers who know about scheduling and want to use WATERIGHT as a tool for more efficient watering schedules.




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Basic Concept – Effective Root Zone

- The Effective Root Zone is that depth of soil, determined by the farmer, where the farmer wants to control soil moisture, tilth, fertilizer, bugs, etc.
- It may or may not be the full extent of rootzone, just what we want to manage.



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### Soil Water Holding Capacity

- Soil “holds” water (against the pull of gravity), retaining it for use by plants (think sponge).
- Described in terms of inches water per inch of soil or inches water per foot of soil.
- Four important levels of water we are interested in...



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## IRRIGATION TECH SEMINAR SERIES

### Soil Water Terminology

- Saturation – most all pore space full, no further infiltration – soil cannot maintain this level.
- Maximum Holding Capacity – time dependent but within operational limits (2-10 days) the most water that the soil will hold against gravity.
- Permanent Wilting Point – plant cannot extract water from the soil – even though it is there.
- Management Allowed Depletion – how much water we want to let the crop use before irrigating.



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### Irrigation Scheduling

- Two major types of irrigation scheduling
  - Water budget – accounts for water going into and out of the effective root zone
  - Graphical (“bottom line”) – uses a soil or plant-based method of moisture measurement to track the trend
- Both trigger irrigations based on a Management Allowed Depletion (or Stress)
- Both are discussed on the WATERIGHT site



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MAD – the “trigger”

- Management Allowed Depletion - generally the amount of moisture I want taken out of the managed root zone by the crop before I irrigate
  - Might be 50% for a flood-irrigated crop
  - Might be 25-30% for drip-irrigated crops
- Could also be a measure of stress (graphical scheduling)
  - Tensiometer reading of 35
  - Pressure Bomb reading

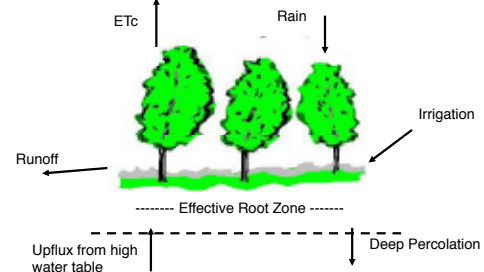


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Water Budget and the Root Zone

$$\text{EndSoilWater} = \text{StartSoilWater} + \text{Rain} + \text{Irr} + \text{Upflux} - \text{ETc} - \text{Deep} - \text{Runoff}$$

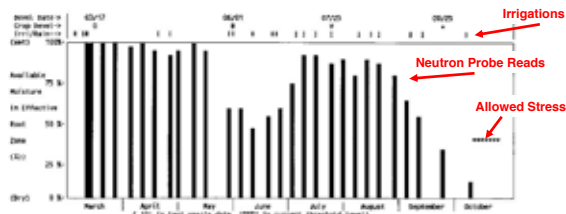
Irrigate when EndSoilWater is at Management Allowed Depletion



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Graphical Scheduling

Pick a soil/plant moisture/stress measurement  
 Measure at certain frequency and graph  
 Irrigate at the Management Allowed Level (Depletion)



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### Knowing “How Much” to Irrigate...

- Water Budget scheduling provides answer directly due to tracking water in and out.
- Graphical gives me the stress point but generally I am always tracking plant water use (water going out of the root zone) to allow an estimate of how much to irrigate.
- Important to be able to estimate plant water use.
  - Allows predictive ability of water budget scheduling.
  - Provides the How Much for graphical scheduling.



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### ET, ETo, ETr

- Evapotranspiration (ET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). It is an indicator of how much water your crops, lawn, garden, and trees need for healthy growth and productivity
- ET from a standardized grass surface is commonly denoted as ETo whereas ET from a standardized alfalfa surface is denoted as ETr.



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### Reference ETo Zones



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## Kc and ETc

- Crop coefficients (Kc) are used with ETo to estimate specific crop evapotranspiration rates, ETc. The crop coefficient is a dimensionless number (usually between .1 and 1.2) that is multiplied by the ETo value to arrive at a crop ET (ETc) estimate. The resulting ETc can be used to help an irrigation manager schedule when an irrigation should occur and how much water should be put back into the soil.



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## Calculating ETc

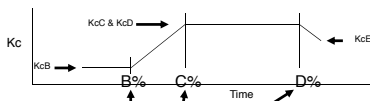
- Example:
  - If, ETo = 0.25 inches/day
  - and, Kc = 0.55 (for an orange tree in July)
  - then, ETc = ETo x Kc = 0.25 inches/day x 0.55 = 0.1375 or 0.14 inches/day



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## Crop Coefficient Samples

UC Davis convention:



Percentage of season to growth stages, crop coefficients, and sample start and end dates

Crop Number	Crop Name	% season B	% season C	% season D	Kc/B	Kc/C	Kc/D	Kc/E	Planting Month	Planting Date	Harvest Month
1.48	Alfalfa (open)	7	18	80	0.40	1.15	1.85	0.40	6	20	7
1.62	Artichokes	6	18	90	0.65	0.65	0.65	0.65	7	1	5
1.63	Asparagus	12	25	95	0.25	1.00	1.00	0.25	3	1	12
1.64	Barley	28	45	75	0.70	1.10	1.80	0.85	11	1	5
1.65	Beans (green)	24	48	80	0.70	0.90	0.90	0.85	6	15	8
1.66	Beans (dry)	24	48	80	0.70	1.00	1.00	0.80	6	15	8
1.67	Beans (pinto)	22	38	88	0.80	1.00	1.00	0.85	5	1	5
1.68	Beans (soy)	25	50	90	0.70	0.90	0.90	0.90	4	1	6
1.69	Beets/Chard	29	50	83	0.80	1.00	1.00	0.80	3	10	7
1.10	Collage	15	60	68	0.90	1.00	1.00	0.85	8	1	11



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### Crop Coefficients

- Leaflets to crop coefficients  
[http://biomet.ucdavis.edu/irrigation\\_scheduling/bis/BIS.htm](http://biomet.ucdavis.edu/irrigation_scheduling/bis/BIS.htm)




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### Where does the ET data come from?

- The California Irrigation Management Information System (CIMIS) is a program of the Office of Water Use Efficiency (OWUE), California Department of Water Resources (DWR) that manages a network of over 120 automated weather stations in the state of California.
- CIMIS was developed in 1982 by DWR and the University of California, Davis to assist irrigators in managing their water resources efficiently. Efficient use of water resources benefits Californians by saving water, energy, and money.




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### How CIMIS works



Source: Department Of Water Resources (2008). CIMIS. Taken from: <http://www.cimis.water.ca.gov/cimis/infoGenCimisOverview.jsp>

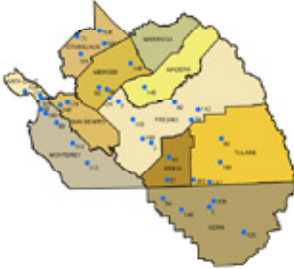




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### CIMIS

- San Joaquin Valley



Map of the San Joaquin Valley showing CIMIS stations. The map is color-coded by region: yellow for the northern part, orange for the central part, and brown for the southern part. Numerous blue dots representing CIMIS stations are scattered across the valley. The logo for the Irrigation Tech Seminar Series and CIT (Center for Irrigation Technology) is in the bottom left corner.

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### CIMIS

- Southern California



Map of Southern California showing CIMIS stations. The map is color-coded by region: yellow for the northern part, orange for the central part, and brown for the southern part. Numerous blue dots representing CIMIS stations are scattered across the region. The logo for the Irrigation Tech Seminar Series and CIT (Center for Irrigation Technology) is in the bottom left corner.

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### Knowing Average ETo and Kcs Allows Predictive Ability

Average Maximum Temperature - San Joaquin Valley, CA



Line graph showing average maximum temperature in inches per day for San Joaquin Valley, CA, by month. The y-axis is labeled 'Inches/Day' and ranges from 0.00 to 0.35 in increments of 0.05. The x-axis is labeled 'Months of the Year' and shows the months J, F, M, A, M, J, J, A, S, O, N, D. The graph shows a seasonal curve that peaks in July at approximately 0.30 inches per day and is lowest in winter months, around 0.05 inches per day.

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## Terms

- **Irrigation Efficiency**
  - Irrigation efficiency (IE) is a measure of how much applied water is used beneficially. A general equation for irrigation efficiency would be:
    - $IE = \text{Beneficial Use of Applied Water} / \text{Total Applied Water}$
  - The two main beneficial uses are crop water use (evapotranspiration, ETC) and leaching to maintain a salt balance.
  - It is not generally possible to achieve 100% IE due to immediate evaporation losses during an irrigation. An exception might be a sub-surface drip system that was managed to under-water the crop.




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IRRIGATION TECH SEMINAR SERIES

## Break Time

10 minute break




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## Example Scheduling


- Under scheduling select "Agriculture."



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## Example Scheduling

- It will take you to this screen. (You will need to allow "cookies" for this site.)



**IT** **CIT**  
Irrigation Technology

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**IRRIGATION TECH SEMINAR SERIES**

## Example Scheduling

- Select "New".

**Agricultural Irrigation Scheduling**

**Field List**  
Click [Edit](#) to modify an existing field or [New](#) to enter a new field.  
Click [Schedule](#) to see the irrigation schedule for that field.

Field Name	Crop	Weather Station	Soil Type	Irr. System		
					<a href="#">New</a>	<a href="#">Schedule</a>
					<a href="#">New</a>	<a href="#">Schedule</a>
					<a href="#">New</a>	<a href="#">Schedule</a>
					<a href="#">New</a>	<a href="#">Schedule</a>

**IT** **CIT**  
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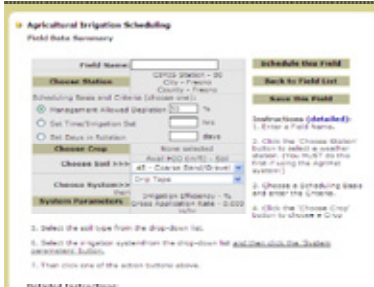
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## Example Scheduling

- A new screen will appear that looks like this. Note the instructions.



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### We Need to Define the “Field”

- These entries will allow WATERIGHT to track the water going into and out of the effective root zone:
  - Climate zone for ETo and Rainfall
  - Crop for Kc, leads to ETc
  - Irrigation system for Net vs Gross irrigations
  - Soil type for water holding capacities
  - Trigger Point – MAD, set time, set rotation or “high frequency” system




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### Example Scheduling

- Enter a Field Name.

Agricultural Irrigation Scheduling

Field Data Summary

Field Name: North Field	Schedule this Field
Choose Station	Back to Field List
CIWS Station - 80 City - Fresno County - Fresno	Save this Field
Scheduling Basis and Criteria (choose one):	
<input checked="" type="radio"/> Management Allowed Depletion: 50 % <input type="radio"/> Set Time/Irrigation Set: _____ hrs <input type="radio"/> Set Days in Rotation: _____ days	
Choose Crop: None selected	




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### Example Scheduling

- Select “Choose Station”.

Agricultural Irrigation Scheduling

Field Data Summary

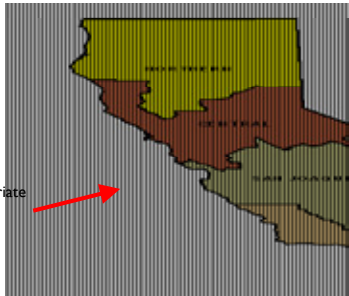
Field Name: North Field	Schedule this Field
Choose Station	Back to Field List
CIWS Station - 80 City - Fresno County - Fresno	Save this Field
Scheduling Basis and Criteria (choose one):	
<input checked="" type="radio"/> Management Allowed Depletion: 50 % <input type="radio"/> Set Time/Irrigation Set: _____ hrs <input type="radio"/> Set Days in Rotation: _____ days	
Choose Crop: None selected	

**Instructions (detailed):**  
 1. Enter a Field Name.  
 2. Click the 'Choose Station' button to select a weather station.



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## Example Scheduling



- Select "San Joaquin" or appropriate region for you.

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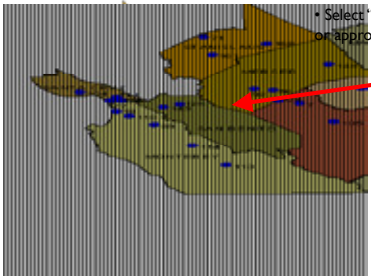
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## Example Scheduling

Central | Northern | San Joaquin | Southern



- Select "Fresno 80 (CSU Fresno)" or appropriate region for you.

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## Example Scheduling

- Click on "Use This Station".

San Joaquin District for CIMIS-DWR Weather Stations

CIMIS Weather Data Report Criteria

For Station 00 - Fresno State, City of Fresno, Fresno County

Use This Station Find Another CIMIS Station

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### Example Scheduling

- Set basis for irrigation – click the Management Allowed Depletion and enter 50
- This means I want 50% of available moisture in the root zone depleted before irrigating

**Agricultural Irrigation Scheduling**

Field Data Summary

<p>Field Number: <input type="text"/></p> <p>Choose Station: <input type="text"/> (CRIS Station - 80, City - Fresno, County - Fresno)</p> <p>Scheduling Basis and Criteria (choose one):</p> <p>Management Allowed Depletion: <input type="text"/> % (50)</p> <p>Set Time/Irrigation Set: <input type="text"/> hrs</p> <p>Set Days in Rotation: <input type="text"/> days</p>	<p>Schedule this Field</p> <p>Back to Field List</p> <p>Save this Field</p> <p>Instructions (detail):</p> <p>1. Enter a Field Name.</p> <p>2. Check the "Choose Station"</p>
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### Example Scheduling


- Choose a crop (click "Choose Crop")
- Note instructions (root depth and ETc adjustment)

**Agricultural Irrigation Scheduling**

Crop Selection/Data Entry

Crop Name: <input type="text"/> Cotton			
Start Month: <input type="text"/> 5	End Month: <input type="text"/> 10	Start Day: <input type="text"/> 10	End Day: <input type="text"/> 15
Start Day: <input type="text"/> 10	End Day: <input type="text"/> 15	Stop 8%: <input type="text"/> 10	Stop 3%: <input type="text"/> 15
Maximum Rooting Depth (feet): <input type="text"/> 4			
ETc Adjustment (%): <input type="text"/> 100			

Instructions:  
 1. Use the pull-down list to choose a crop.  
 2. Defaults will appear in the other entry boxes. Check these and change as necessary.  
 3. You may want to come back and change the ETc Adjustment if the resulting irrigation schedule does not appear reasonable for your conditions.




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### Example Scheduling

- It will take you to the new screen below.
- Select "Back to Field Entry".


**Agricultural Irrigation Scheduling**

Crop Data Entry

Crop: Cotton    Period: 15 May - 15 Oct

(Refer to Instructions at page bottom for explanation of variables)

A - 15 May	B - 7 Jun	C - 22 Jun	D - 22 Sep	E - 15 Oct
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### Example Scheduling

- Once all the required information has been entered and selected click "Schedule This Field".

**Agricultural Irrigation Scheduling**  
Field Data Summary

Field Name: North Field

Choose Station: CIMIS Station - 80  
City - Fresno  
County - Fresno

Scheduling Basis and Criteria (choose one):  
 Management Allowed Depletion 50%  
 Set Time/Irrigation Set  
 Set Days in Rotation

Choose Crop: Cotton  
 Crop Season: 5/15 6/15 - 10/15  
 Stop Irrigating: 10/15  
 Reschedule: 4 best  
 ETc Adjust: 100%  
 Avoid Irrig (dWts) - Soil

Choose Soil: Alluvial Sandy Loam (S)

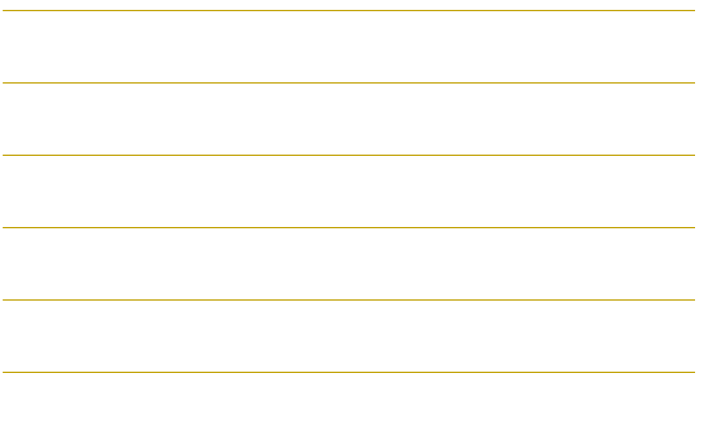
Choose Scheduling Basis: Surface Irrigation

System Parameters: Irrigation Efficiency - 75%  
 Allowed Depletion - 20% of SDR

**Schedule This Field** (indicated by a red arrow)

Back to Field List  
Save This Field

Instructions (Detailed):  
 1. Enter a Field Name.  
 2. Click the 'Choose Station' button to select a weather station. (You MUST do this first if using the AgriNet system).  
 3. Choose a Scheduling Basis and enter the Criteria.  
 4. Click the 'Choose Crop' button to choose a Crop.



**Agricultural Irrigation Scheduling**  
Seasonal Irrigation Schedule

- (IMPORTANT!)**
- Please refer to the notes at the bottom of this page for information on how the schedule was calculated.
  - Users **ABSOLUTELY** need to verify the plant health and soil moisture in their fields.
  - This is an **AVERAGE SEASONAL** schedule and should be used as **INITIAL GUIDANCE ONLY**.

The Irrigation Schedule status is below the Field Data Summary.

Field Data Summary

CIMIS Sta:	Fresno State (80)
City of Fresno in Fresno County	
Field Number	1
Description	North Field
Crop	Cotton
Crop Season	5/15 - 10/15
Stop Irrigating	5/15
Soil	Fine Sandy Loam
Minimum Root Zone (Z)	4
Irrigation System	Surface
Irrigation Efficiency	75%
% of Field Irrigated	100
Scheduling Basis	Max. Allowed Depletion
Management Allowed Depletion	50%
Allowed Depletion at Max. Allow (Zd)	3.91



IRRIGATIONTECH SEMINAR SERIES

Seasonal Irrigation Schedule

For Week Ending	Average Year		This Year		Averages For Week			Change This Wk vs Avg Yr	Tol (ETc to Date)
	ETc	Rain	ETc	Rain	In/Dy	Pt. In	%		
5/22/2009	0.23	0.08	N/A	N/A	0.35	0.08	1.00	1.96	N/A
5/29/2009	0.21	0.09	N/A	N/A	0.35	0.08	1.71	3.25	N/A
6/5/2009	0.26	0.07	N/A	N/A	0.36	0.09	2.63	5.15	N/A
6/12/2009	0.27	0.08	N/A	N/A	0.46	0.11	3.55	4.95	N/A
6/19/2009	0.28	0.03	N/A	N/A	0.71	0.18	4.00	7.82	N/A
AVG. YEAR: Irrigate 4/26/2009: Net= 3.99 In, Gross= 5.32 In.									
6/26/2009	0.29	0.00	N/A	N/A	0.89	0.24	4.00	7.82	N/A
7/3/2009	0.29	0.00	N/A	N/A	0.93	0.24	4.00	7.82	N/A
AVG. YEAR: Irrigate 3/5/2009: Net= 4.84 In, Gross= 5.32 In.									
7/10/2009	0.29	0.00	N/A	N/A	0.95	0.26	4.00	7.82	N/A
7/17/2009	0.29	0.00	N/A	N/A	0.95	0.26	4.00	7.82	N/A
AVG. YEAR: Irrigate 7/16/2009: Net= 4.02 In, Gross= 8.37 In.									
7/24/2009	0.29	0.00	N/A	N/A	0.95	0.26	4.00	7.82	N/A
7/31/2009	0.28	0.00	N/A	N/A	0.95	0.24	4.00	7.82	N/A
AVG. YEAR: Irrigate 6/2/2009: Net= 3.95 In, Gross= 5.26 In.									

Assumes that you can control the irrigation event so as to apply about 5.3 inches gross at 75% IE









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### Scheduling “High Frequency” Systems

- Example output says 27 hrs, 48 min for week of June 3 – this will replace net ETc for those 7 days (assuming full ETc)
- The question is whether the soil moisture is at 30% depletion or 60% depletion?
- Because the 27 hrs 48 min will keep the soil moisture the same (if 60% - bad).



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IRRIGATION TECH SEMINAR SERIES

Questions

QUESTIONS?



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IRRIGATION TECH SEMINAR SERIES

### Break

- 10 minute break



IRRIGATION TECH SEMINAR SERIES

### Examples

- Your specific examples



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IRRIGATION TECH SEMINAR SERIES

### Other Software

- For other Irrigation Software go to:  
<http://www.cimis.water.ca.gov/cimis/infoIrrSoftware.jsp>



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# NOTES

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# NOTES

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