Effects of Sprinkler, Reduced Sprinkler/ Drip, and Drip Only Irrigation on Strawberry Transplants

2012-2013 Data

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Summary

For the past five growing seasons, the Cal Poly ITRC has conducted research on water use, salinity levels and various other factors related to strawberry transplant establishment. This report is a summary of work and current data that can be found online at the ITRC website (www.itrc.org/projects.htm).

This project's original purpose was to develop an analysis of irrigation practices of the strawberry growers on the central coast of California, primarily during the establishment of transplants. Traditional irrigation practices involved using sprinklers for several weeks after transplanting, which strained the capacity of the local water supply systems and generated large volumes of runoff from the fields. When asked why sprinklers were used for irrigating and not drip systems, growers expressed concerns about the sensitivity of the transplants to salinity. It was a common belief that drip irrigation would not be able to leach the salts out of the plants' root zones.

Growers from Oxnard, Santa Maria and Watsonville participated in the study to provide a good cross section of the region's strawberry growing areas. Research areas and control plots were set up on a demonstration scale in order to determine relationships between the use of irrigation water and the control of salinity. The project was extended for multiple years in order to examine the long-term salinity impacts on yields. The overall goal of the project was to minimize or even eliminate sprinkler use on strawberries, thereby conserving water, saving pumping costs, and reducing the runoff that can potentially contaminate local waterways.

Results from the project indicate that yields <u>can</u> be maintained and water use <u>can</u> be decreased through increased use of drip irrigation during transplant establishment. The key determinant in the transition to new irrigation management is salinity, which comes from many sources and must be effectively managed.

Introduction

The California Polytechnic State University (Cal Poly) Irrigation Training & Research Center (ITRC), in collaboration with academic, water district, and industry partners, implemented a multi-year study to evaluate new strategies for drip irrigation on strawberries to minimize water use during transplant establishment.

The project started in the fall of 2008 with a capacity issue on the Pumping Trough Pipeline (PTP), which is managed by the United Water Conservation District and supplies growers in the Oxnard area. At the time, strawberry growers would all plant during the same period in October (using sprinklers on the new transplants between five and eight weeks after transplanting) and the demand created by sprinkler irrigation exceeded the pipeline's capacity. Faced with complaints of poor service, the district felt the best course of action was to regulate the use of sprinklers in October, and threatened to ban sprinkler irrigations for strawberry growers during that month. Local growers requested assistance to determine alternate irrigation methods. The simplest option was to use the drip irrigation system that is already installed when the transplants are brought to the field, but growers were concerned about the effects of salinity without sprinklers.

After five years of evaluation and testing, the most common method used for irrigating strawberries is now reduced sprinkler. Growers use sprinklers for bed preparation and salinity control, then eventually switch to drip after transplanting. They continue to use sprinkler irrigation as an insurance policy to prevent plant and soil bonding, clean off the leaves, control salinity, and prevent frost damage, even though field observations have shown that only a small portion of the water applied by sprinklers actually infiltrates through the plastic mulch to the deeper plant roots.

The key objectives of the project were to:

- Keep strawberry transplants healthy
- Switch to drip irrigation as soon as possible

Specifically, this involved the following steps:

- Set up research areas and control plots on a demonstration scale
- Determine key factors that affect the problems in early growth of transplanted strawberries
- Determine relationships between the use of irrigation water and the control of salinity
- Provide a multi-year analysis to determine long-term salinity impacts on yields

Materials and Methods

<u>DU Evaluations of Drip Irrigation Systems</u>
Distribution uniformity (DU) evaluations were performed on drip irrigation systems in fields in Watsonville, Santa Maria, and Oxnard. The goal was to analyze current irrigation strategies and offer suggestions to potentially conserve water and reduce energy costs for growers. A high distribution uniformity (greater than 0.85) is a good indicator that water is being supplied evenly across fields and few, if any, improvements are needed to the maintenance strategy or design of the irrigation system.

<u>Salinity Monitoring Sites</u>
Test Sites. This project consisted of blocks of strawberry plants in fields across the central coast of California (Table 1). These test sites were selected to represent the areas of California where strawberries are commonly grown.

Table 1. Participating strawberry sites in the fifth year of the study using reduced sprinkler method, listed by region

Santa Maria	Oxnard	Watsonville
Manzanita 2	Sammis	Corey Ranch
Manzanita 7	Doris Ranch	Porter Ranch - RSI
	Peikert Ranch	Trafton Ranch - RSI
	Eclipse Berry Farms	

<u>Irrigation Methods to Evaluate</u>
The research evaluation identified three irrigation methods as test protocols:

- *Sprinkler Irrigation Only (SIP)* – every day for up to six weeks, then switch to drip irrigation (this protocol is referred to as the “conventional” approach). The key issue with the SIP conventional protocol is the amount of runoff generated during transplant establishment. It is estimated that approximately 50 to 75% of the applied water will run off the field.
- *Reduced Sprinkler Irrigation (RSI)* – use sprinklers only for special cases for 3 to 8 irrigation events (e.g., right after transplanting, during hot dry wind events, frost protection), depending on extreme weather conditions such as the Santa Ana events
- *Drip Irrigation Only (DIO)* – every day for the whole season

<u>Flow Meters</u>
Magnetic flow meters were chosen as a flow measurement device for the project due to their high reliability, ease of installation, and accuracy. A magnetic flow meter or “magmeter” has no moving parts and does not require the pipe to be full in order to make accurate measurements. It also has the ability to totalize flows and provide an accurate volumetric reading. This was a necessity as all water use numbers

would need to be compared volumetrically. Also, magmeters are much less sensitive to turbulent flows than most other flow measurement devices. This allowed the meter to be installed in close proximity to elbows or valves, which made the installation very convenient. Both types of magnetic flow meters used are made by SeaMetrics and have a rated accuracy of ±1%.

<u>Internet Monitoring – Ranch Systems and ClimateMinder</u>
To simplify data acquisition, several growers implemented data monitoring systems from Ranch Systems and ClimateMinder. These companies offer a variety of products to allow active monitoring of in-field conditions. Generally, this information can be posted on the internet in real-time. The theory was that not only would the data be logged, but valuable irrigation scheduling information would be readily available to the growers. The following paragraphs describe the process used to monitor data collected by Ranch Systems monitors; the ClimateMinder monitoring uses a similar system.

Base Station
A crucial part of the Ranch Systems setup is a base station that relays all information collected by the nodes to the Ranch Systems network. This allows the information to be presented on the Ranch Systems website and accessed by users.

Nodes
Nodes are the devices that collect field sensor readings and transmit them to the base station. They consist of a solar panel, radio, and in this case, soil and pressure sensors. Each node was connected to two Decagon 5TE soil moisture/temperature/electrical conductivity (EC) sensors and one Decagon PS1 pressure switch. The 5TE sensors were run down the strawberry bed and placed at a depth of 3 inches in each of the two middle plant rows. The PS1 pressure switch was connected using a brass T connection to a nearby sprinkler head in order to monitor the duration and frequency of sprinkler irrigations.

Data Collection from Ranch Systems Sensors
Collecting data from the Ranch Systems sensors requires simply accessing the Ranch Systems website, logging on and selecting the node of interest. However, this study found that the data from Ranch Systems was extremely unreliable and proved to be of little use. The sensors tended to fail and due to the complexity of the system, it was too difficult to repair/replace them.

Data Loggers
Decagon Em50 data loggers were installed at every site at the Oxnard, Santa Maria and Watsonville locations. These small data loggers were placed on the end of a block, near the middle row. Their compact size allowed them to be placed virtually anywhere in the field without the risk of damage from passing equipment. Each data logger was connected to two Decagon 5TE soil moisture/temperature/EC sensors and one Decagon PS1 pressure switch. The 5TE sensors were run down the strawberry bed and placed at a depth of 3 inches in the middle plant row. To monitor moisture and water movement in the root zone, additional 5TE sensors were installed at depths of 6 and 12 inches. The PS1 pressure switch was connected using a brass T connection to a nearby sprinkler head in order to monitor the duration and frequency of sprinkler irrigations.

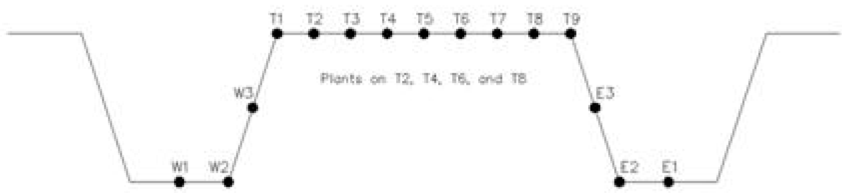
<u>Data Collection</u>
Data collection consisted of simply visiting each site and downloading the logged data onto a laptop. This was done on a weekly basis during the period of transplant establishment. This allowed for frequent analysis of soil salinity levels during the most sensitive growth period. During the later stages of growth, data was collected on a bi-weekly basis as the strawberry plants are much more resistant to salinity during this period. Generally, the data loggers required little maintenance. About once per season, the batteries had to be changed and occasionally a 5TE sensor would fail. These sensors proved to be much more useful than the Ranch Systems data monitoring system.

Soil Sample Procedure
Periodically throughout the growing season, soil samples were taken in order to monitor the specific salt concentrations present in the soil. This was done by pulling samples from 0-3 inches, 3-6 inches, and 6-12 inches from the two middle plant rows. The EC and soil moisture content were also checked at each

of the three depths using a handheld Decagon ProCheck device with a 5TE sensor. The samples were taken from near the center of the field close to where the 5TE data logger sensors were located. The locations of the samples vary somewhat between dates but for a given date, each sample was taken from the same spot in each field.

Salinity 5TE Shallow Analysis
In an attempt to track the movement of salts, EC measurements were taken across the top of the strawberry bed at a depth of 3 inches on numerous occasions throughout the growing season. This was done using a handheld Decagon ProCheck device with a 5TE sensor. Measurements were taken at the nine locations shown in Figure 1. These measurements were taken near the middle bed at both ends of each block. The locations of the measurements vary somewhat between dates, but for a given date, each measurement was taken from the same spot in each field.

Shallow Soil Analysis (Topo) - Top 3 Inches
Sammis Strawberries



Using ProCheck and 5TE Sensor
= Salinity >8

Sammis: 11/4/2012

West → East

Sammis	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	8.77	4.87	8.33	7.55	2.62	2.11	8.22	12.2	11.6	4.73	8.64	7.93	10.1	4.9	8.98
Temp(F)	70.3	68.2	66.7	62.5	65.5	64.9	64.9	64.9	65.1	66.2	66.7	67.5	71.8	73	72.1
% Moisture	27.4	25.6	21.2	17.6	20.7	22.8	23.9	25.2	26.1	23.3	24.6	23.1	25.4	21	29.1

Figure 1. Salinity 5TE Shallow Analysis, shows the salinity, temperature and percent moisture trends across strawberry beds

Water Sample Procedure
Water samples were taken whenever water was on the site. This gave some idea as to the quality of the irrigation water that was being used at each site. A waterproof total dissolved solids tester was used to test samples.

Photo Log Procedure
Pictures were taken of each test site during each visit. This allowed the growth process of strawberries at each site to be monitored and later compared. All pictures were taken facing north from the location of the data logger in each field. One of the best methods to determine the health of the transplants during establishment has been the evaluation of the photos. Figure 2 shows one of the photo comparison composites that was used to evaluate plant health and growth.

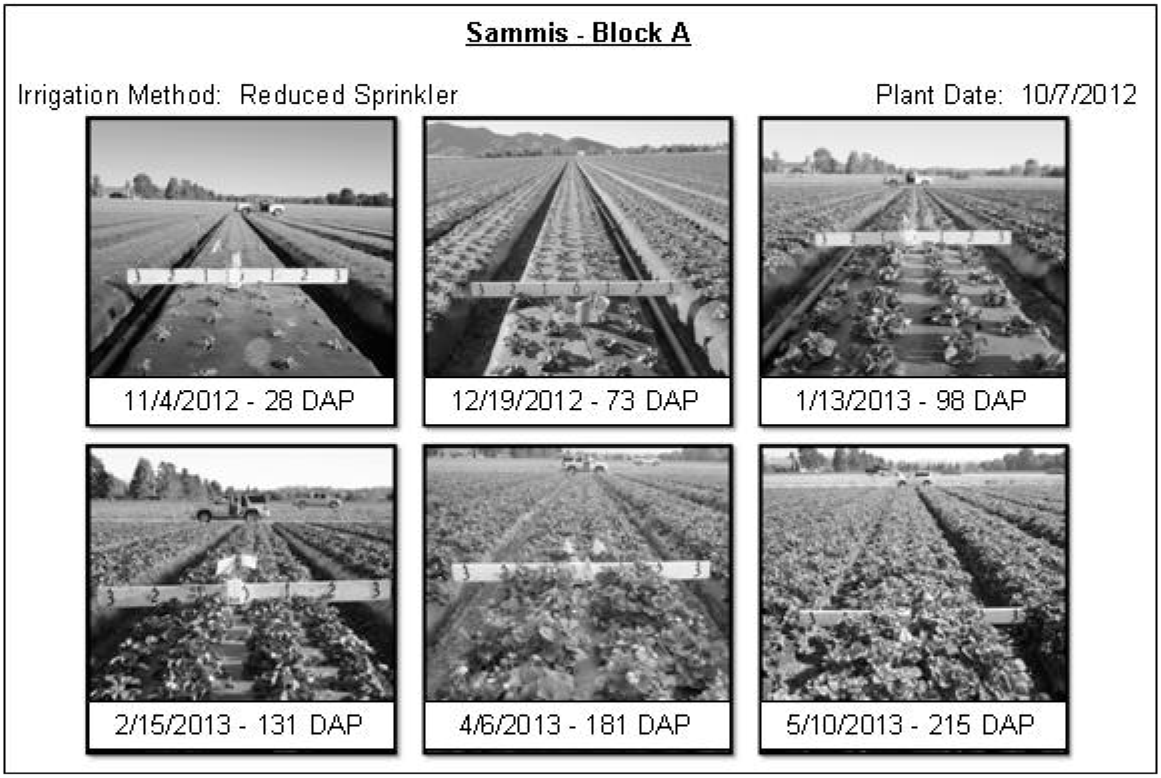


Figure 2. Photo comparison for Sammis Block A, shown by days after planting (DAP)

Results

Distribution Uniformity Evaluations

The desired DU value for all of the fields was 0.85, which is the statewide average for all drip irrigation systems. The results from the DU evaluations are presented in Table 2. Proper design and maintenance are important in order to maximize distribution uniformity over the entire growing season. This may include:

- Installing pressure regulators at the head of each manifold, or adjusting regulators to the correct setting
- Adequately backflushing filters
- Routinely flushing hoses and repairing leaks

Table 2. Distribution uniformity results of fields along the central coast.

Farm	Location	System DU
Manzanita 2	Santa Maria	0.84
Manzanita 7	Santa Maria	0.86
Gamble Ranch	Santa Maria	0.80
Los Padres Berry Farm	Santa Maria	0.90
Sammis	Oxnard	0.67
Eclipse Berry Farm (1)	Oxnard	0.73
Eclipse Berry Farm (2)	Oxnard	0.74
Peikert Ranch	Oxnard	0.76
Corey Ranch	Watsonville	0.87

The DU evaluations were repeated each year. There was a noticeable difference in DU scores over the last two seasons due to the time in the season the evaluation was performed and increased grower awareness of uniformity problems. Growers have started to place more emphasis on maintaining a consistent pressure distribution over the entire field. There is also a substantial difference in the drip system's performance over the length of the growing season.

Soil Salinity Continuous Data

All continuous data was obtained from the Decagon data loggers rather than the Ranch Systems monitoring system. The Ranch Systems nodes and sensors proved unreliable early in the season and were quickly abandoned. Similar problems occurred occasionally with the Decagon data loggers, but the problems were much less frequent.

The resulting data was highly variable between all of the test plots. This made a statistical analysis of the salinity data infeasible. Clearly there is a tremendous amount of uncertainty associated with managing salinity. Additionally, the charts clearly show the huge effect that rainfall has on salinity. The data showed that a heavy rain in January lowered salinity levels by up to 50% while sprinkler irrigation events had much less impact on the soil salinity. This was primarily due to the fact that the rainwater has a low pH value and no salt content.

From the soil salinity data collected, salinity contours graphs were made (shown earlier in Figure 3). The graphs display values of salinity (dS/m) in the plant beds. These are useful to the grower for analyzing where the salt is pushed by applied water. The darkest grey color signifies EC values of 10 dS/m or higher, which is considered toxic to the plant if not leached.

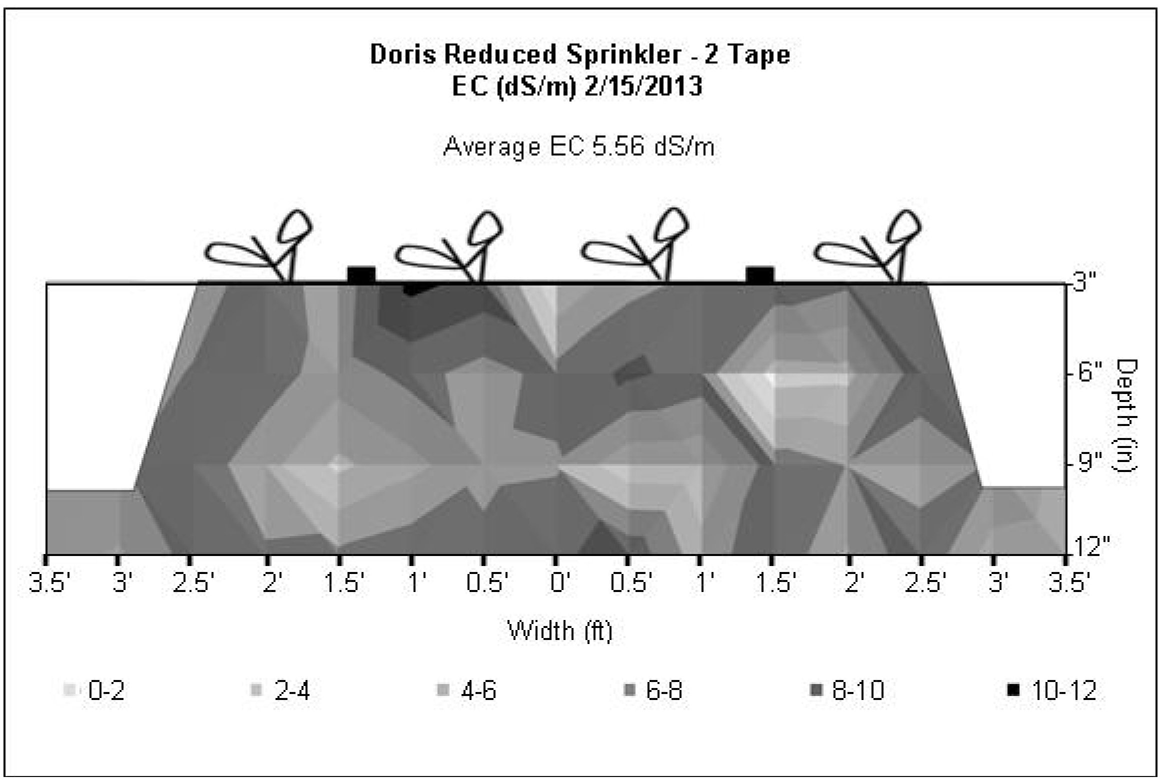


Figure 3. Salinity contour graph (dS/m) at Doris site

Rainfall Data

The data from the sensors was uploaded to a spreadsheet. This spreadsheet contained data from the entire study, displaying salinity levels in both water and soil. It also contained precipitation data, as well as number of minutes the sprinklers were running. All of the data was collected from the fields except for the precipitation data. The precipitation data was obtained from California Irrigation Management Information System (CIMIS 2013) or the Weather Underground (Weather Underground 2013) websites using the nearest airports as the location. After all of the data was uploaded into the spreadsheet, graphs were made to visually monitor the salinity levels.

The salinity levels displayed in the graph (Figure 4) showed some common trends. The salinity levels fluctuated daily. There were noticeable drops in the salinity level after periods of rain. This would indicate local leaching had occurred near the sensors. Then the salinity levels would begin to rise after the rain subsided. However, this held true for the sensors only in the 0”-3” range. The sensors deeper than that did not record as prominent of a fluctuation. This would indicate there was not a lot of downward movement of the irrigation water.

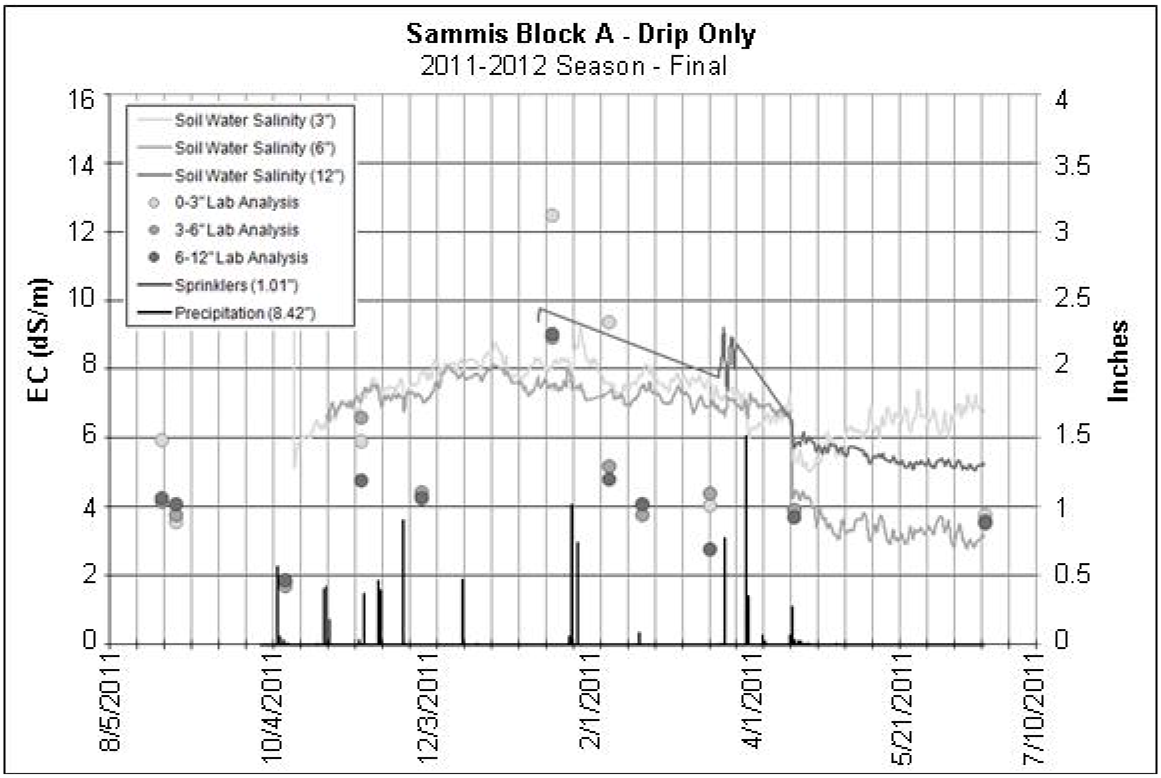


Figure 4. Sample salinity graph from Sammis Block A, salinity is measured at 3, 6 and 12 inch depths.

<u>Water Use Data</u>

Throughout the season, the water use at the sites was monitored by periodic meter readings. The trends could be viewed over several seasons. The total water was found to be around the same each year (Figure 5). The total water seemed to decrease over the span of the study, but it must be noted that the amount of total water is also dependent on weather conditions, which vary by year.

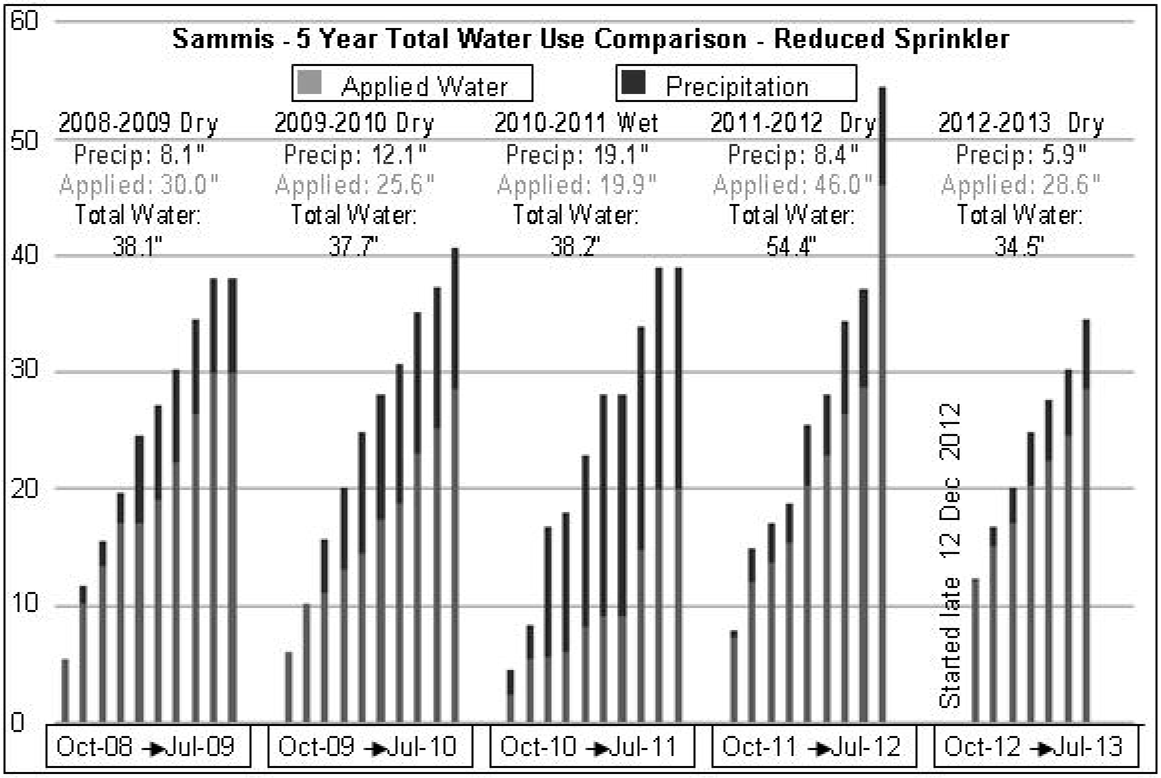


Figure 5. Water use comparison at Sammis Block A showing total water, including precipitation and applied water, for five growing seasons

<u>Impact on Yields</u>

The yields in the first and second season showed little impact due to the irrigation method. However, in the first season there was noticeable damage to plants where the salinity levels were very high due to the placement of the drip irrigation tape. The conclusion was that even though there was some die-off, the other plants seemed to respond better, which kept the yields about equal to previous years. The other conclusion was that the placement of the drip tape was important.

The data from Sammis in the second year also indicated that the yields improved using the new irrigation methods. The reduced sprinkler protocol had an 8% increase in yield and the drip only protocol had a 13% increase in yield.

The third season yields were higher with the new irrigation protocol. The yield increase in Manzanita was 13% on the reduced sprinkler protocol compared to the conventional protocol. The grower also reported the yields on the reduced sprinkler protocol resulted in early field gains at a time when the market prices were favorable.

The fourth year of data saw a dramatic drop-off in the data collection of yields by the early innovators. These growers switched their whole fields over to the new protocol and abandoned the “conventional” irrigation approach, with the exception of the Sammis site.

The fifth year yields grew at a fast rate, but then declined rapidly earlier in the season than in previous years. Figure 6 shows a side-by-side comparison of yields over the five growing seasons of the study for Sammis using the reduced sprinkler method.

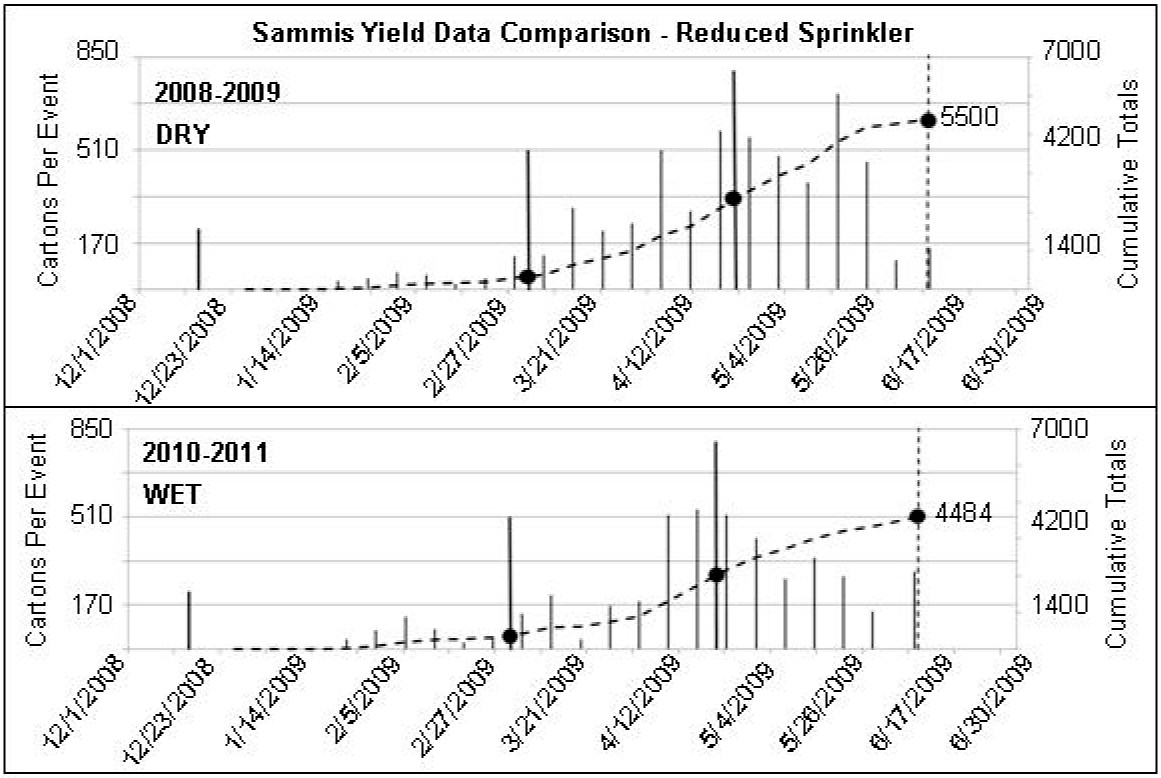


Figure 6. Yield data from Sammis for five strawberry seasons.

Preliminary conclusions can be drawn from the graphs used in the evaluation (examples shown in Figures 5 and 6):

- Annual water use tends to remain consistent between growing seasons, with the exception of Sammis during the fourth growing season.
- Yields fluctuate on a year-to-year basis based on numerous factors. The overall weather seems to be a major determinant on yields. Rainfall was less abundant during the first year of the project. The third year had three times more rainfall than the first. The hotter, dryer weather may have led to better yields in the first year. Keep in mind that the first year on the drip only saw a 30% die-off due to salinity damage.

Discussion

The results from the first and second year were mixed due to some major die-off issues (up to 30% in one demonstration plot). The first year seemed to be dominated by low rainfall and numerous Santa Ana wind events. While generally unsuccessful in terms of results, the grower wanted to continue the study since the potential seemed promising, and there were numerous key lessons learned.

The third year showed increases in yield and decreases in water use. There were decreases in water use of up to 10% and a surprising increase in yields was reported.

The fourth year focus shifted to a more detailed analysis. For example, is 4-tape better than 2-tape? If 2-tape will work, what are the soil texture characteristics that will allow that to happen? There were some key items that were noticed by the end of the study period:

- Salinity is a key determinant in the healthy establishment of the strawberry transplants. The young plants will not tolerate high levels of salts. The damage in the plants will appear similar to a plant that lacks sufficient water.

- Row crop drip tape must be placed correctly in order to micro-leach salts in the beds. This means that in the Oxnard Plain, growers may need to use four low flow tapes in order to successfully switch to the drip only or reduced sprinkler protocols. Growers in Santa Maria might be able to use only two tapes per bed (on lighter soils) but the salinity must be evaluated in order to make sure the salts are not building up at the base of the plant. Using three tapes is not recommended on beds with four plant rows. However, it is being done on a number of ranches.
- Monitoring the salinity of the soil and the irrigation water will help growers switch from the conventional irrigation method to a new protocol. The soil salinity should be less than 7 dS/m (EC_e) and the water salinity should be less than 1.0 dS/m (EC_w). Monitoring can be done with portable measurement equipment but should be verified using professional soil labs.
- The irrigation water is one of the key determinants of whether there may be a problem. If the water quality is 1.0 dS/m or less, the impact is minimal. If the salinity of the irrigation supply water is 1.2 dS/m, the grower could see a 10 to 25% yield impact. It should be noted that well water, surface water, and reclaimed water sources have changing salinity characteristics during the season.
- Salts come from various sources. Some sources of salt include the irrigation water, gypsum applications, fertilizers (both pre-plant and liquid), and composting (which can be a significant source).
- Traditional salinity references have used soil salinity as the key determinant for the salt impact on yields. The traditional approach states that if the soil salinity (EC_e) approaches 4.0 dS/m the yield will be 100% impacted (i.e., no yield). However, this research confirmed most growers in the Oxnard Plain routinely work in soils at 4-6 dS/m with very little impact on yields. The reason is that they have been managing their salts properly near the roots of the young plants.
- Soils that are lighter will be easier to irrigate and manage than soils that are heavy. This has been observed in the various plots as part of this research.
- Rain washes salts away from young strawberry transplants. The data clearly show that rainwater (which is essentially salt-free and acidic) can push harmful salts away from the plants. The data show how dramatically the salinity level dropped after the rain.
- The new protocols result in a yield increase up to 10%. The new protocols have also decreased the water use by over 10%. This research project has shown that the new approach has resulted in more crops per drop.

The fifth year focused a lot of attention on distribution uniformities. Of the nine evaluated sites, the average distribution uniformity is 0.80. This is below the statewide average due to pressure variability seen across some of the evaluated strawberry fields. Overall, results seemed promising with higher uniformities than previous years.

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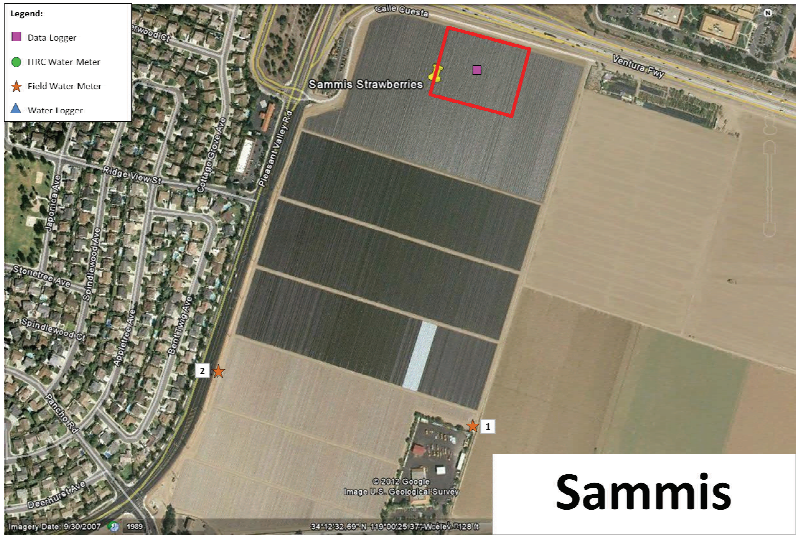
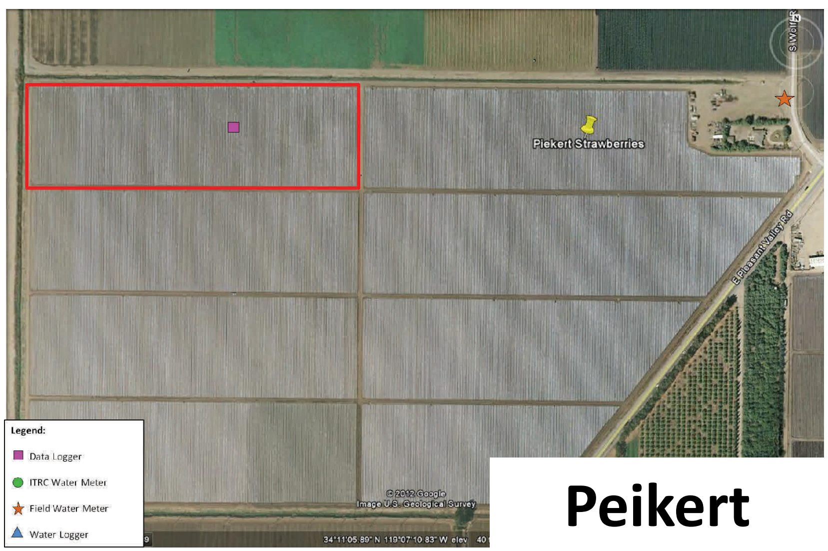
Oxnard/Camarillo Blocks

2012-2013

Oxnard Area

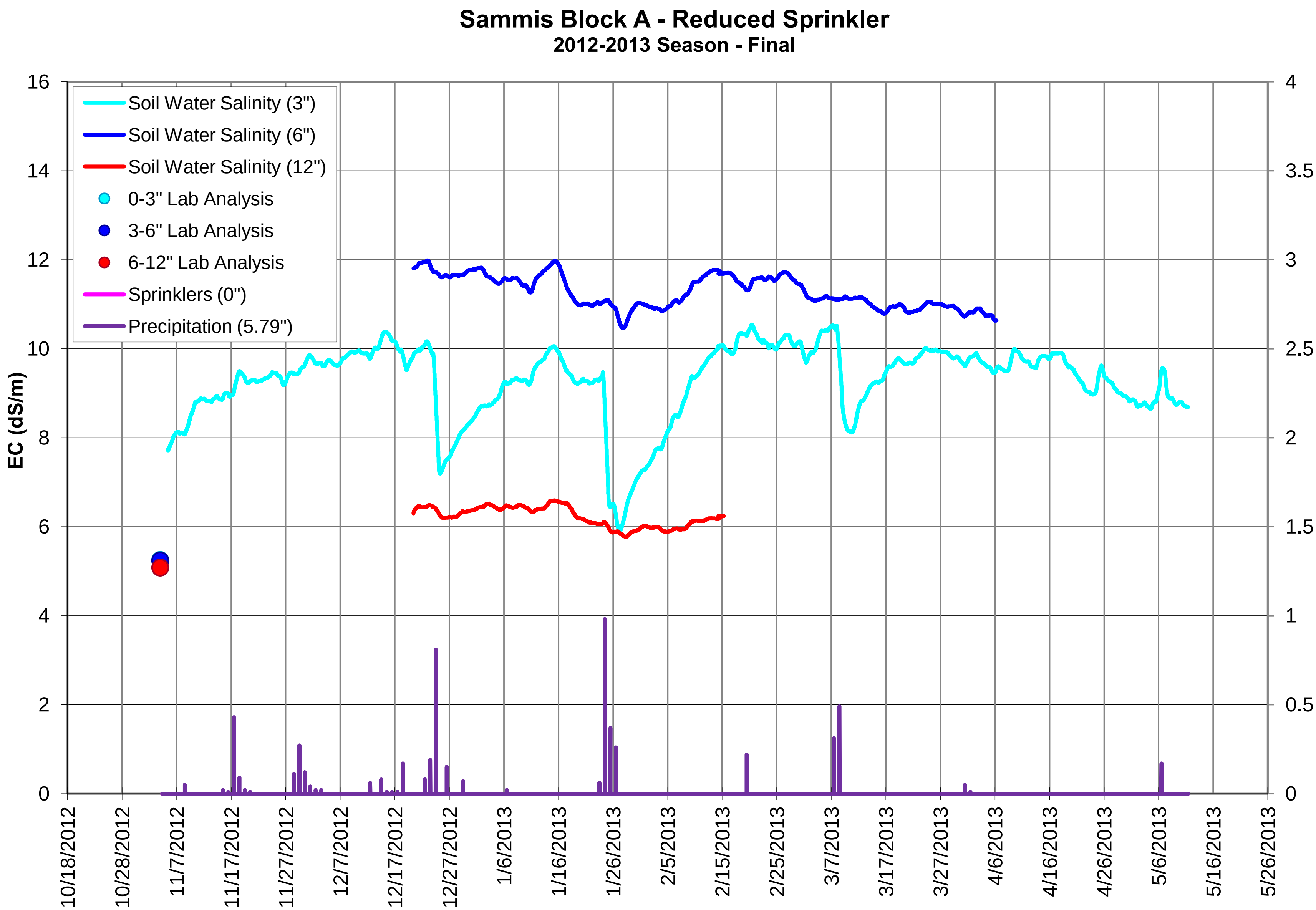

Legend:
Data Logger
ITRC Water Meter
Field Water Meter
Water Logger
Sammis Strawberries
Sammis


Legend:
Data Logger
ITRC Water Meter
Field Water Meter
Water Logger
Eclipse Strawberries
Eclipse


Peikert Strawberries
Legend:
Data Logger
ITRC Water Meter
Field Water Meter
Water Logger
Peikert


Legend:
Data Logger
ITRC Water Meter
Field Water Meter
Water Logger
Doris

Sammis


Sammis Block A - Reduced Sprinkler
2012-2013 Season - Final
EC (dS/m)
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (5.79")
0
2
4
6
8
10
12
14
16
0
0.5
1
1.5
2
2.5
3
3.5
4
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012
12/7/2012
12/17/2012
12/27/2012
1/6/2013
1/16/2013
1/26/2013
2/5/2013
2/15/2013
2/25/2013
3/7/2013
3/17/2013
3/27/2013
4/6/2013
4/16/2013
4/26/2013
5/6/2013
5/16/2013
5/26/2013

Sammis – Block A

Irrigation Method: Reduced Sprinkler

Plant Date: 10/7/2012

11/4/2012 – 28 DAP

12/19/2012 – 73 DAP

1/13/2013 – 98 DAP

2/15/2013 – 131 DAP

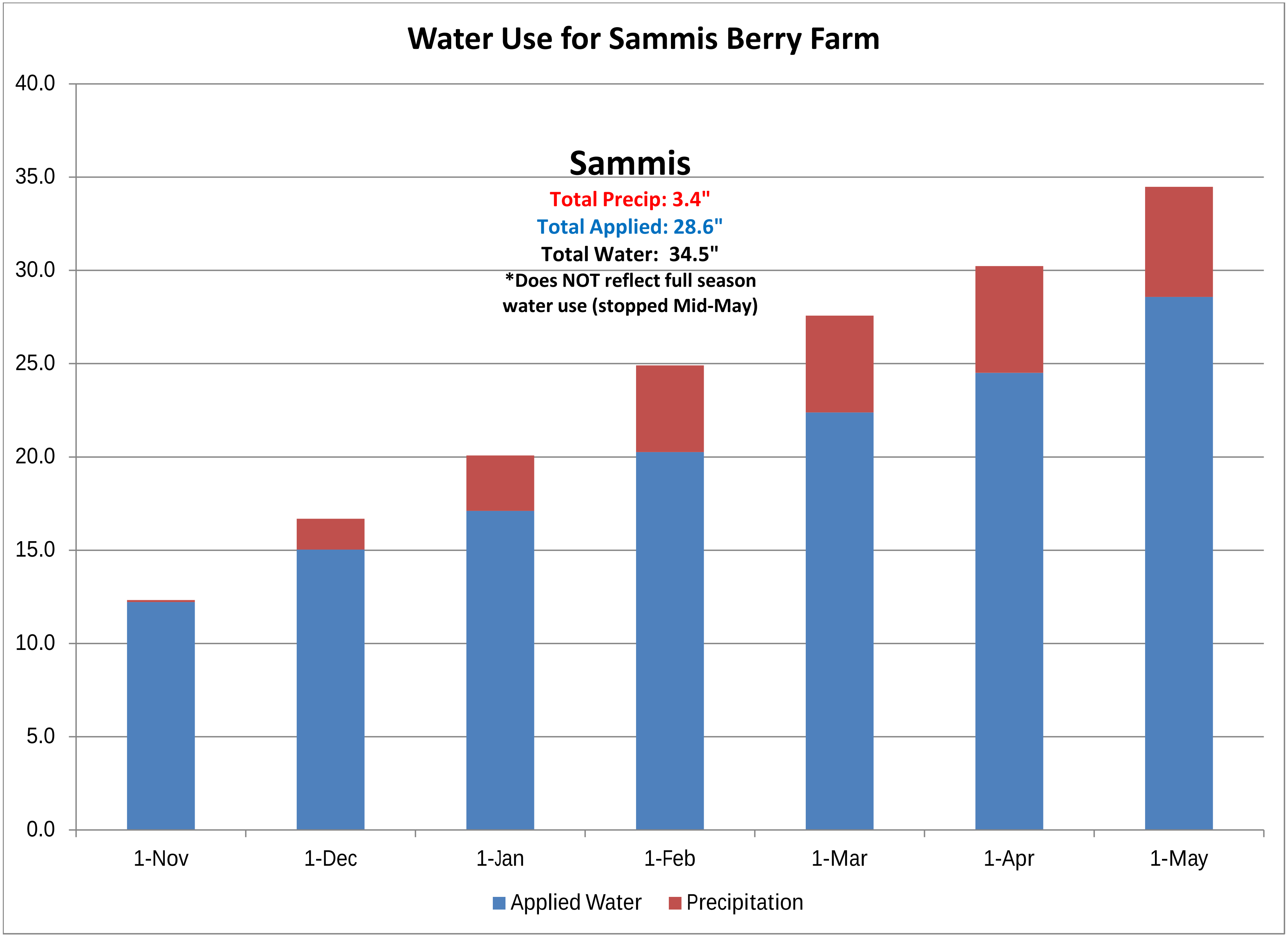
4/6/2013 – 181 DAP

5/10/2013 – 215 DAP

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Sammis Blocks

Date:		11/4/2012									
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	5.25	279.30								
	3-6"	5.24	300.30								
	6-12"	5.08	296.10								

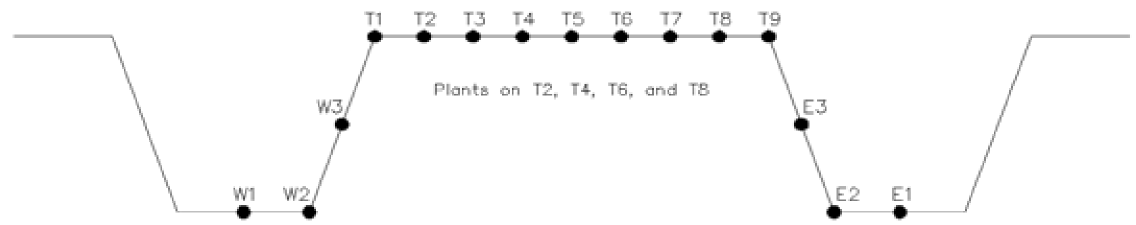
Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler


Water Use for Sammis Berry Farm
Sammis
Total Precip: 3.4"
Total Applied: 28.6"
Total Water: 34.5"
*Does NOT reflect full season water use (stopped Mid-May)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
Applied Water
Precipitation

Shallow Soil Analysis(Topo) - Top 3 inches
Sammis Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Sammis 11/4/2012

Sammis	West													East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	8.77	4.87	8.33	7.55	2.62	2.11	8.22	12.23	11.67	4.73	8.64	7.93	10.11	4.9	8.98
Temperature (F)	70.3	68.2	66.7	62.5	65.5	64.9	64.9	64.9	65.1	66.2	66.7	67.5	71.8	73	72.1
% Moisture	27.4	25.6	21.2	17.6	20.7	22.8	23.9	25.2	26.1	23.3	24.6	23.1	25.4	21.5	29.1

Sammis 12/19/2012

Sammis	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	7.33	14.16	12.34	15.92	10.27	16.9	12	13.42	8.58	12.38	8.42	11.68	1.64	10.42	10.72
Temperature (F)	51.5	50.9	50.7	50	49.5	49.1	49.3	49.5	50	50.4	50.4	50.5	52.3	53.4	53.2
% Moisture	24.1	20.8	19.9	18.4	20.3	21.7	21.4	20.1	20	22.5	21.7	19.4	21.9	23.5	27

Sammis 1/13/2013

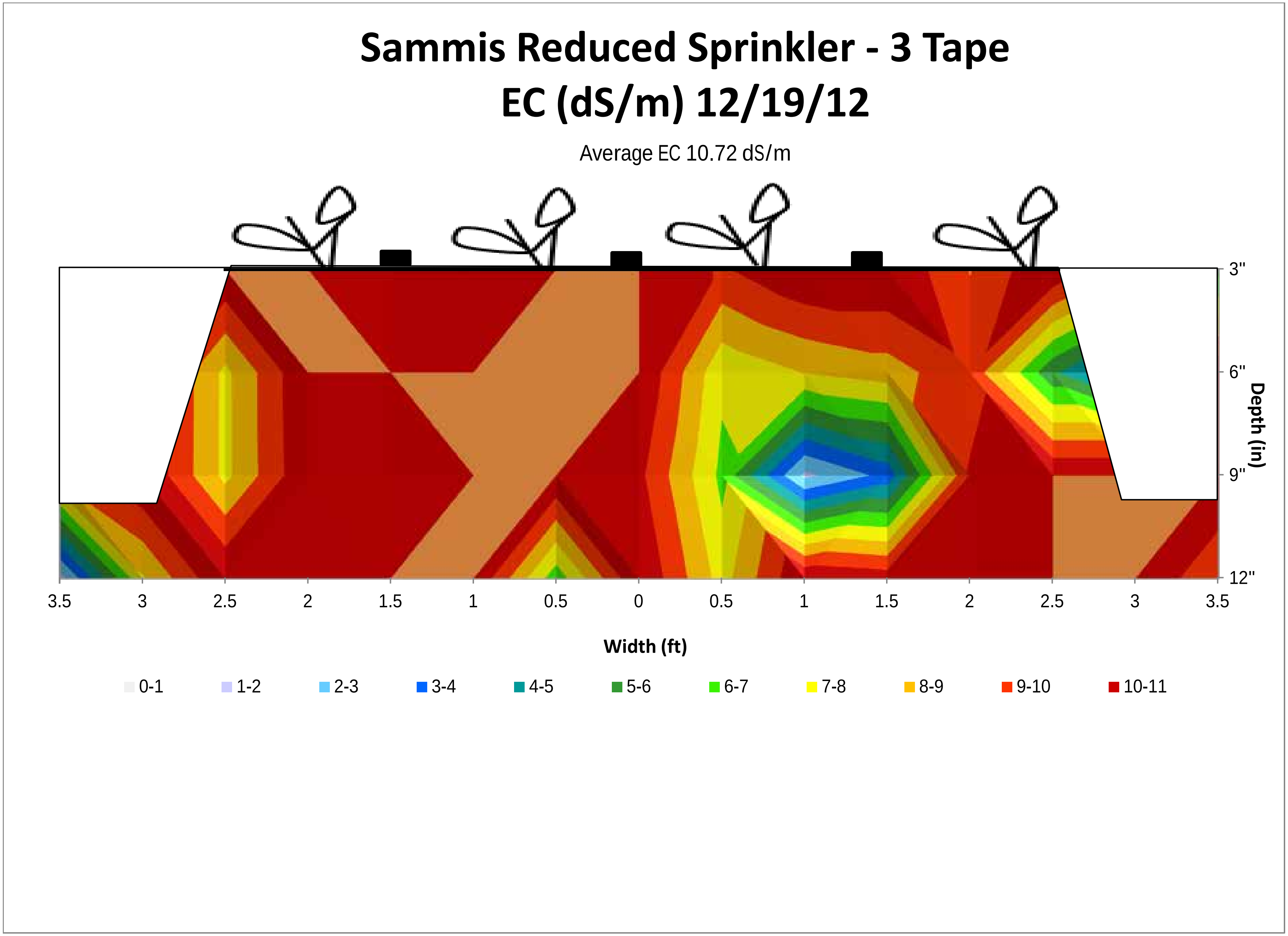
Sammis	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	16.09	15.5	16.8	17.7	11.13	11.7	6.7	17.9	17.1	5.4	16.1	23.7	18.7	x
Temperature (F)	x	42.1	41.2	41.2	40.8	41	41.4	41.4	41	41.4	41.2	40.6	40.1	39.9	x
% Moisture	x	23.3	21.2	22	23.6	24.4	21.6	32.2	22.2	22.6	22.3	20.7	20.2	22.3	x

Sammis 2/15/2013

Sammis	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	1.32	4.49	8.94	6.23	5.71	20.45	6.42	10.18	5.96	12.76	2.09	14.41	2.81	x
Temperature (F)	x	56.8	55.2	51.4	52	51.8	52.3	52.7	52.9	53.4	54	54.5	54.1	53.8	x
% Moisture	x	24	33.5	24.3	24.2	24.1	24.3	16.1	25.9	35.1	24.4	39.9	74.9	35.4	x

Sammis 4/6/2013

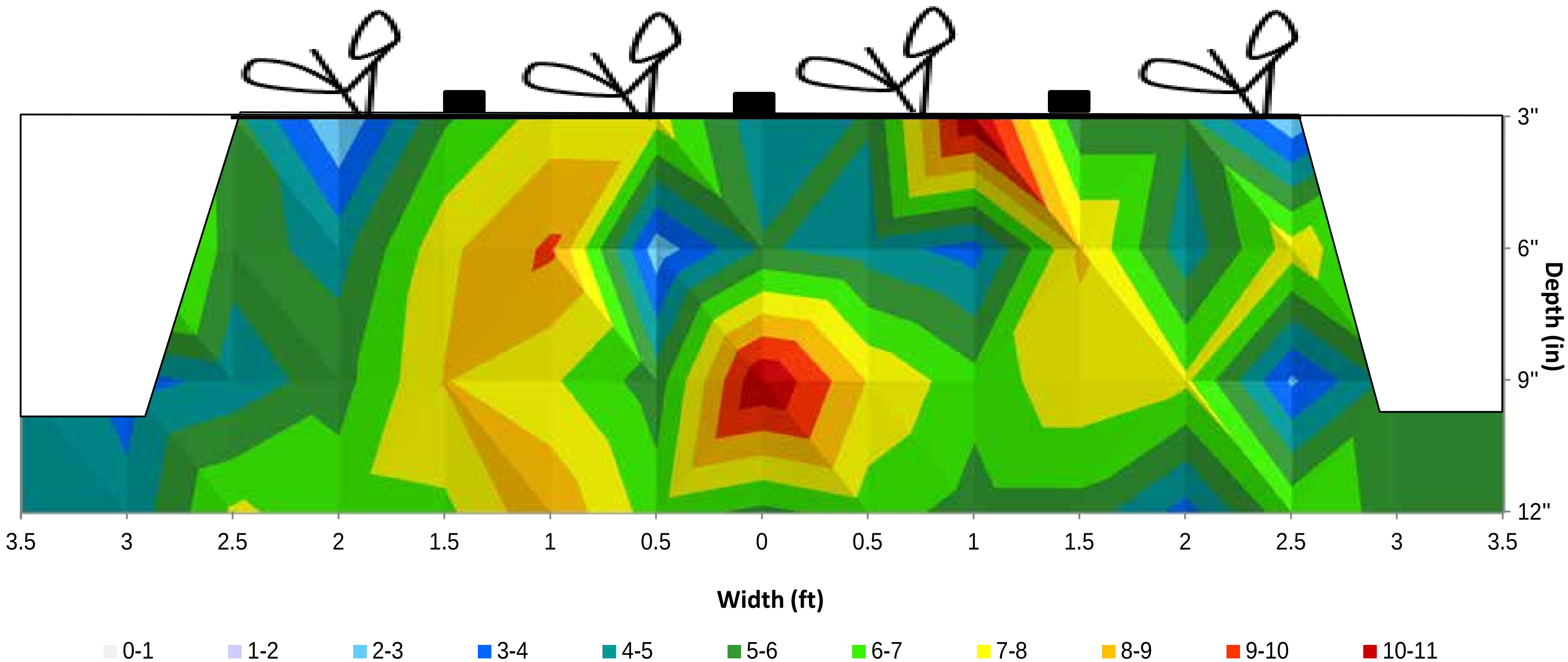
Sammis	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	17.26	5.76	27.54	15.89	11.42	16.8	11.72	12.15	7.59	19.58	16.91	11.6	14.65	x
Temperature (F)	x	62.2	62.4	61.9	61.5	61.3	60.6	60.3	59.9	59.7	59.5	59.7	59.7	59.5	x
% Moisture	x	26.8	23.3	21.8	25.1	27.8	23	23.3	17.6	20.8	21.4	23	20.2	22.3	x



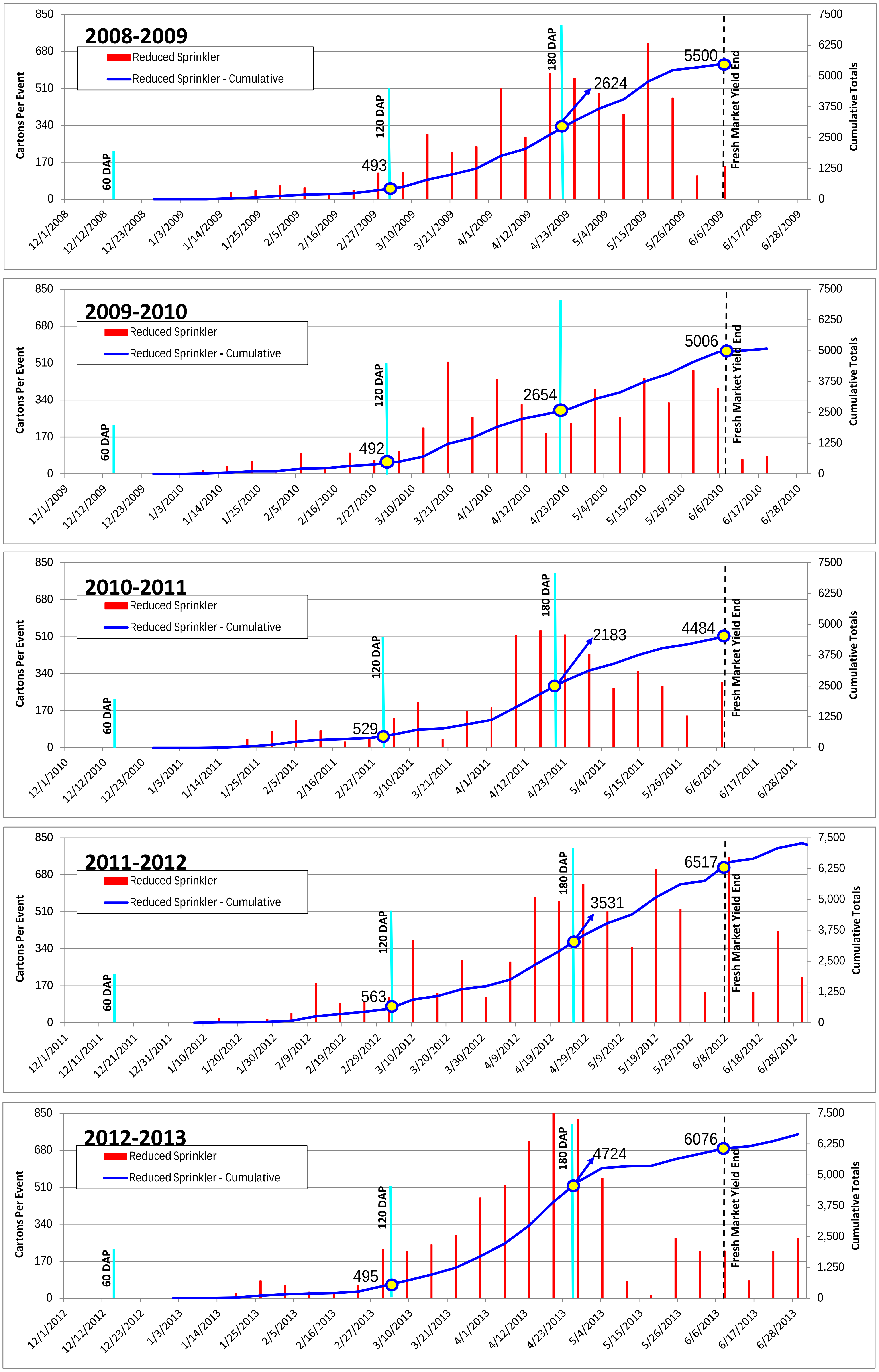
Sammis Reduced Sprinkler - 3 Tape
EC (dS/m) 12/19/12
Average EC 10.72 dS/m
3"
6"
9"
12"
Depth (in)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Width (ft)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11

Sammis Reduced Sprinkler - 3 Tape
EC (dS/m) 2/15/13

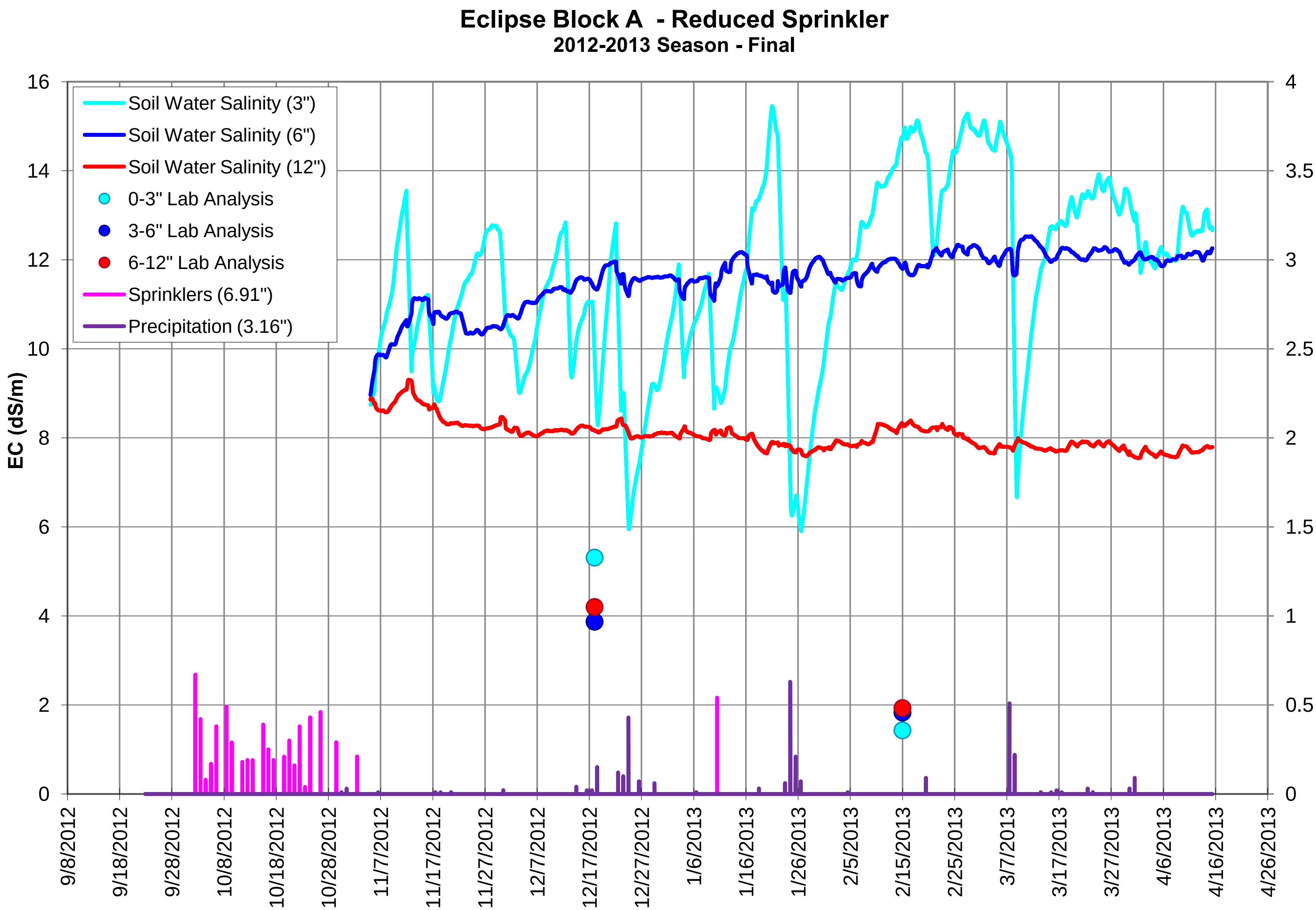
Average EC 5.88 dS/m



Sammis Yield Data Comparison - Reduced Sprinkler



Eclipse



Eclipse Block A - Reduced Sprinkler
2012-2013 Season - Final
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (6.91")
Precipitation (3.16")
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012
12/7/2012
12/17/2012
12/27/2012
1/6/2013
1/16/2013
1/26/2013
2/5/2013
2/15/2013
2/25/2013
3/7/2013
3/17/2013
3/27/2013
4/6/2013
4/16/2013
4/26/2013

Eclipse – Block A

Irrigation Method: Partial Sprinkler **Plant Date: 10/10/2012**

9/25/2012 – (-15) DAP

11/4/2012 – 25 DAP

12/18/2012 - 69 DAP

1/13/2013 – 95 DAP

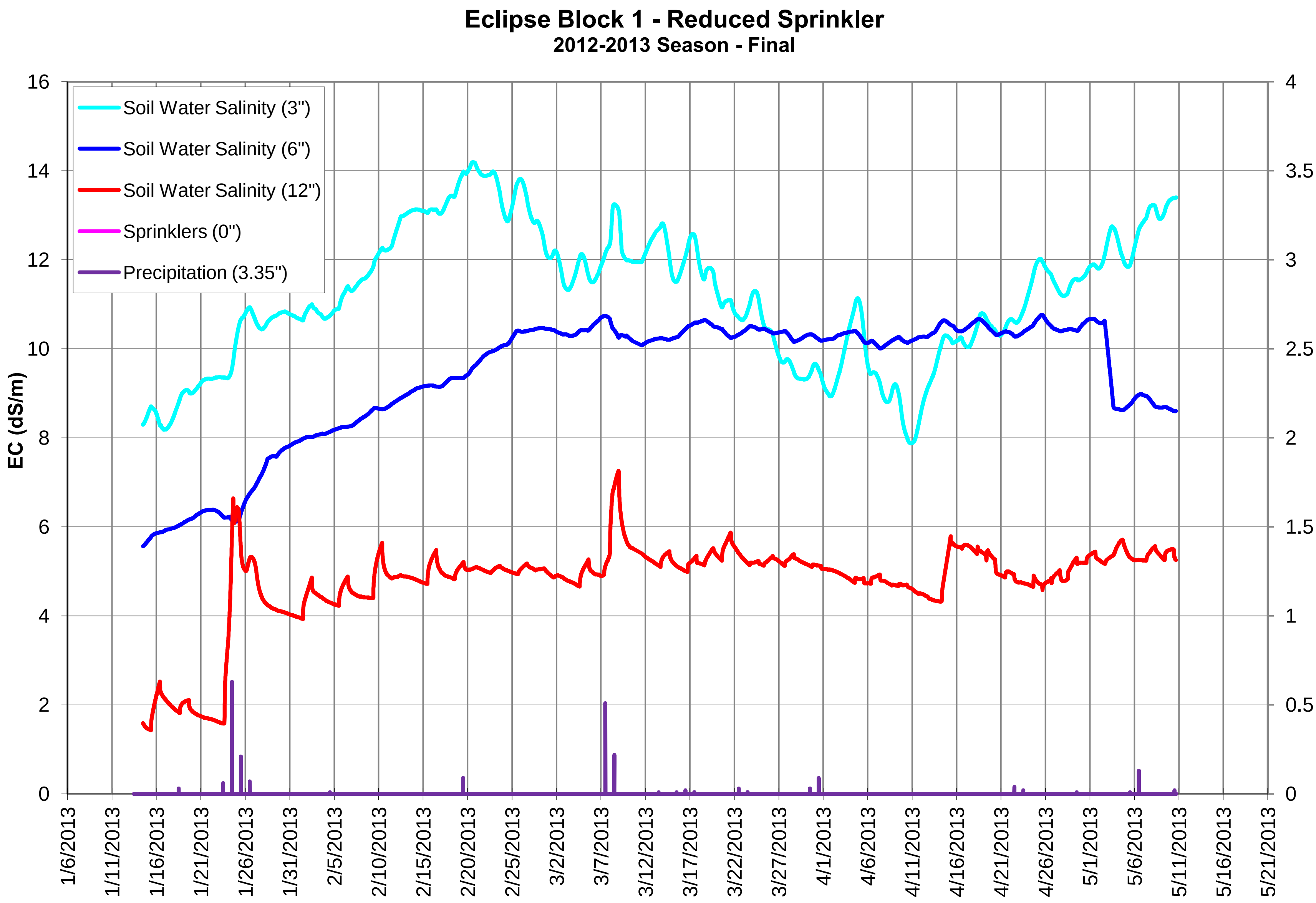
2/15/2013 -128 DAP

4/6/2013 -178 DAP

Eclipse – Block A

Irrigation Method: Partial Sprinkler

Plant Date: 10/10/2012



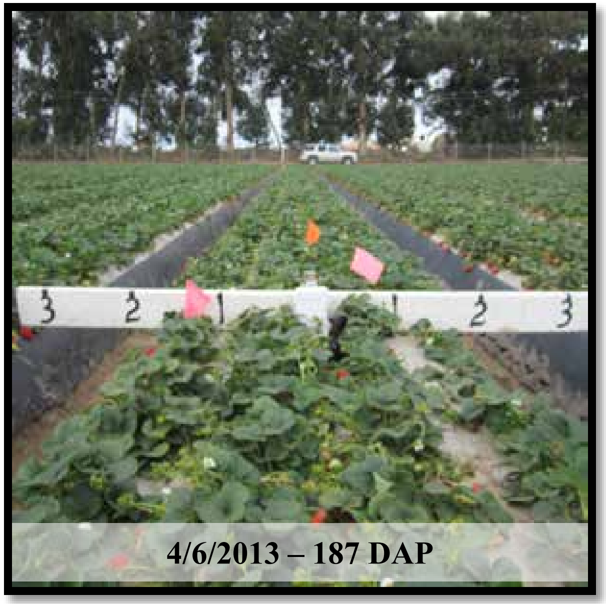
Eclipse Block 1 - Reduced Sprinkler
2012-2013 Season - Final
EC (dS/m)
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
Sprinklers (0")
Precipitation (3.35")
0
2
4
6
8
10
12
14
16
0
0.5
1
1.5
2
2.5
3
3.5
4
1/6/2013
1/11/2013
1/16/2013
1/21/2013
1/26/2013
1/31/2013
2/5/2013
2/10/2013
2/15/2013
2/20/2013
2/25/2013
3/2/2013
3/7/2013
3/12/2013
3/17/2013
3/22/2013
3/27/2013
4/1/2013
4/6/2013
4/11/2013
4/16/2013
4/21/2013
4/26/2013
5/1/2013
5/6/2013
5/11/2013
5/16/2013
5/21/2013

Eclipse – Block 1

Irrigation Method: Reduced Sprinkler **Plant Date: 10/1/2012**

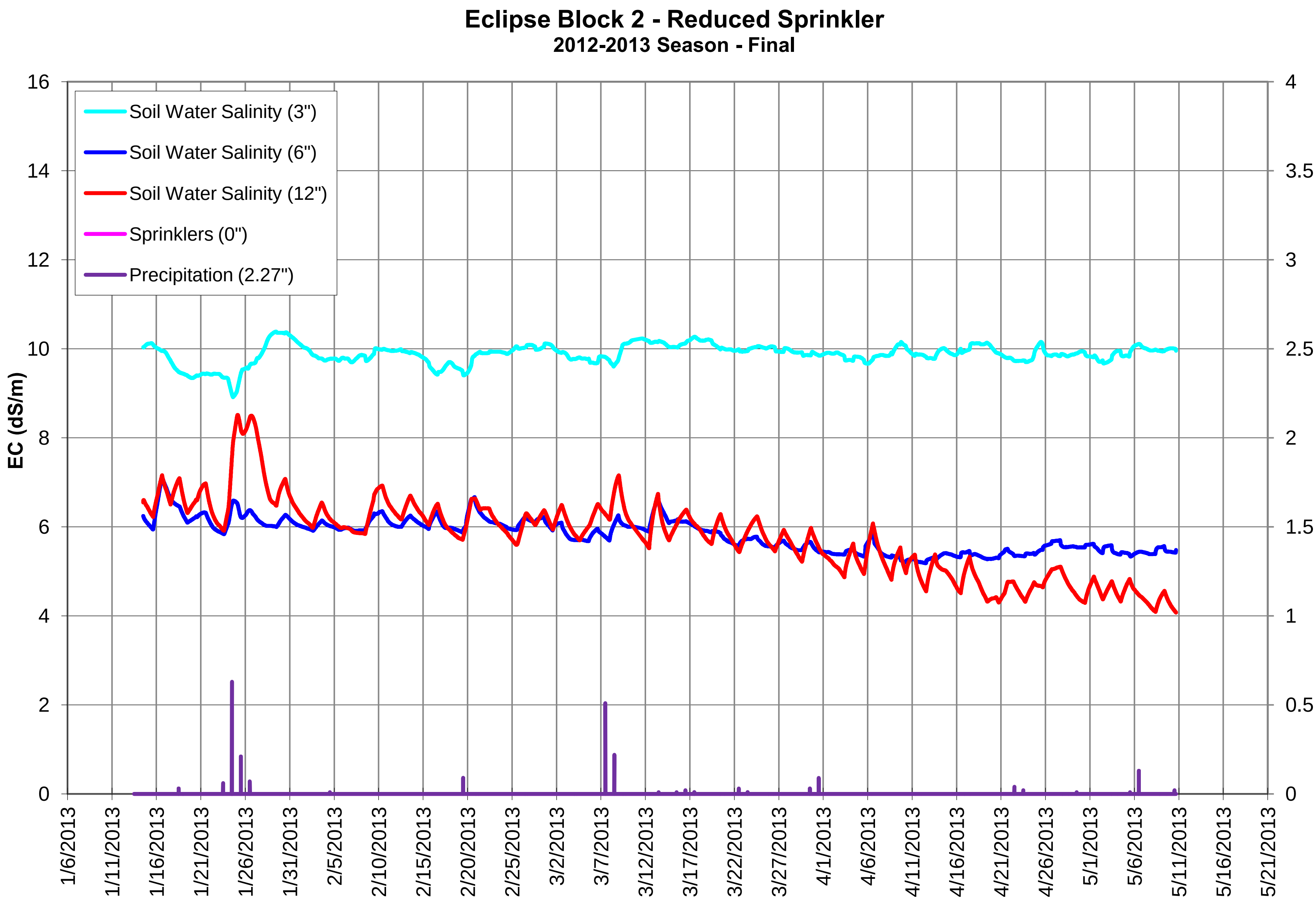
1/13/2013 – 104 DAP

3/10/2013 - 160 DAP



4/6/2013 – 187 DAP

5/10/2013 – 221 DAP



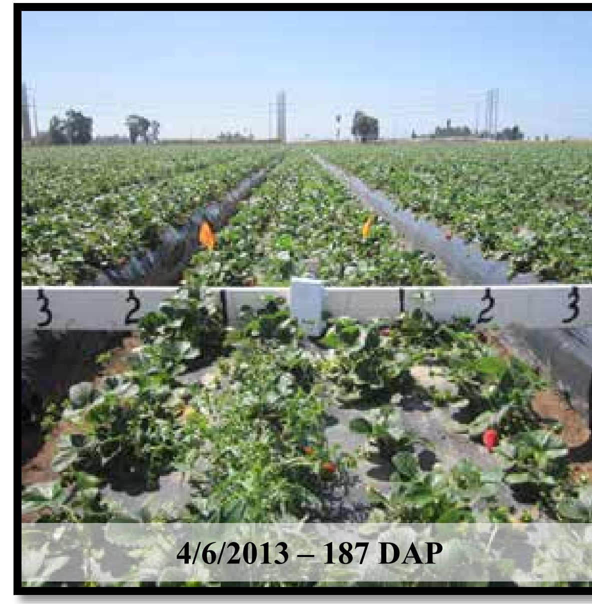
Eclipse Block 2 - Reduced Sprinkler
2012-2013 Season - Final
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
Sprinklers (0")
Precipitation (2.27")
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/6/2013
1/11/2013
1/16/2013
1/21/2013
1/26/2013
1/31/2013
2/5/2013
2/10/2013
2/15/2013
2/20/2013
2/25/2013
3/2/2013
3/7/2013
3/12/2013
3/17/2013
3/22/2013
3/27/2013
4/1/2013
4/6/2013
4/11/2013
4/16/2013
4/21/2013
4/26/2013
5/1/2013
5/6/2013
5/11/2013
5/16/2013
5/21/2013

Eclipse – Block 2

Irrigation Method: Partial Sprinkler **Plant Date: 10/1/2012**


1/13/2013 – 104 DAP


3/10/2013 – 160 DAP

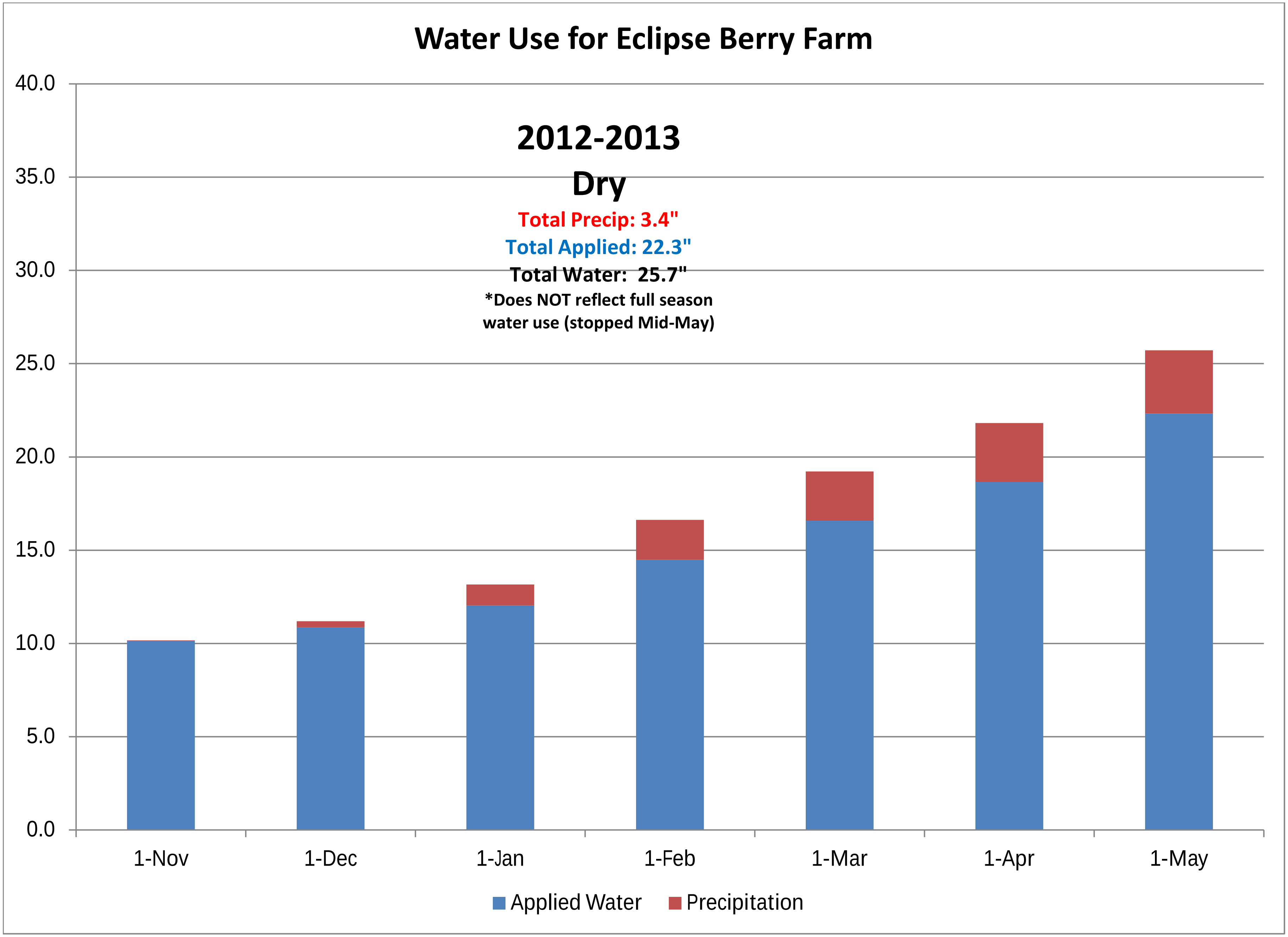

4/6/2013 – 187 DAP


5/10/2013 – 221 DAP

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Eclipse Blocks

Date:		12/18/2012		2/15/2013							
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	5.31	195.30	1.43	28.00						
	3-6"	3.87	68.60	1.83	42.70						
	6-12"	4.20	58.80	1.93	41.30						

Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler

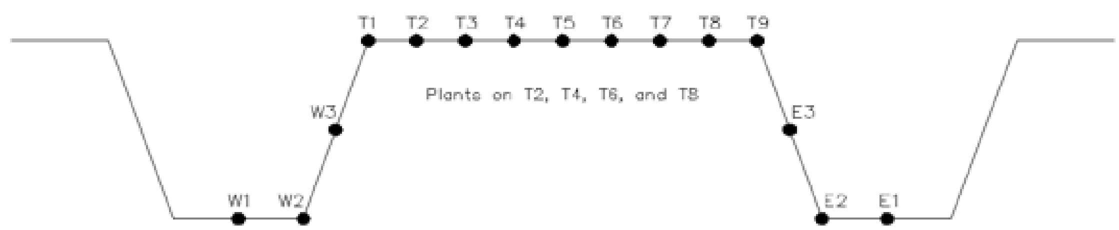


Water Use for Eclipse Berry Farm
2012-2013
Dry
Total Precip: 3.4"
Total Applied: 22.3"
Total Water: 25.7"
*Does NOT reflect full season water use (stopped Mid-May)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
Applied Water
Precipitation

Shallow Soil Analysis(Topo) - Top 3 inches
Eclipse Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Eclipse **11/4/2012**

Eclipse	West													East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	4.8	7.5	9.3	8.5	13.4	16.8	14.9	10.1	7.7	8.5	7.8	7.8	9.6	7.2	8.1
Temperature (F)	103.3	97.7	95.5	94.1	92.3	90.3	89.4	88.7	88.2	86.9	86.5	85.8	85.8	86.0	85.5
% Moisture	28.5	25.7	27.3	31.1	21.0	24.1	22.1	24.6	17.3	23.4	24.4	21.1	20.7	25.1	27.3

Eclipse **12/19/2012**

Eclipse	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	X	7.9	4.7	11.2	4.8	6.6	5.3	11.3	6.3	8.2	6.2	8.3	4.5	3.7	X
Temperature (F)	X	57.7	57.0	56.3	55.6	55.2	55.6	55.2	55.0	54.9	55.4	54.9	55.8	56.7	X
% Moisture	X	23.0	18.7	18.4	22.1	21.9	24.1	22.2	22.8	22.4	20.2	21.4	21.1	23.9	X

Eclipse **1/13/2013**

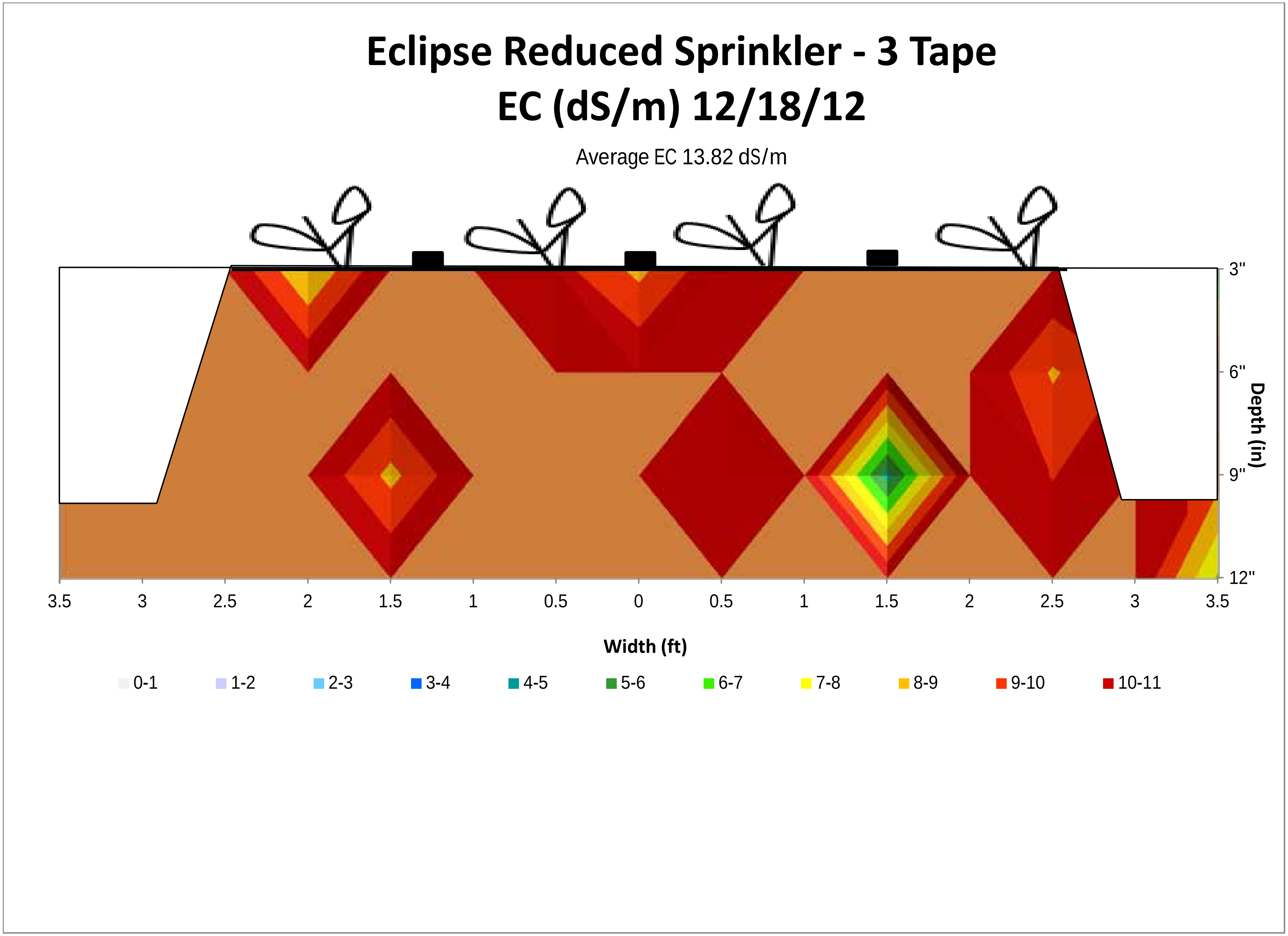
Eclipse	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	9.81	7.62	8.32	9.91	7.35	10.2	6.61	5.69	6.33	3.37	12.79	7.94	10.48	x
Temperature (F)	x	44.8	44.1	44.4	45.1	44.6	44.2	44.1	43.5	43.3	43.0	41.9	41.2	41.2	x
% Moisture	x	24.3	21.7	22.6	25.1	23.6	27.0	26.0	30.3	25.2	27.0	21.6	26.0	26.9	x

Eclipse **2/15/2013**

Eclipse	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	4.62	1.31	1.44	12.08	4.84	11.24	12.33	5.67	14.55	16.69	18.48	2	3	x
Temperature (F)	x	69.3	68.2	65.5	64.9	64.4	64.9	67.3	68.2	68.4	68.7	68.9	71.1	71.4	x
% Moisture	x	31.1	28.5	34.0	24.4	21.6	28.6	25.4	31.3	24.3	24.8	23.2	25.9	25.9	x

Eclipse **4/6/2013**

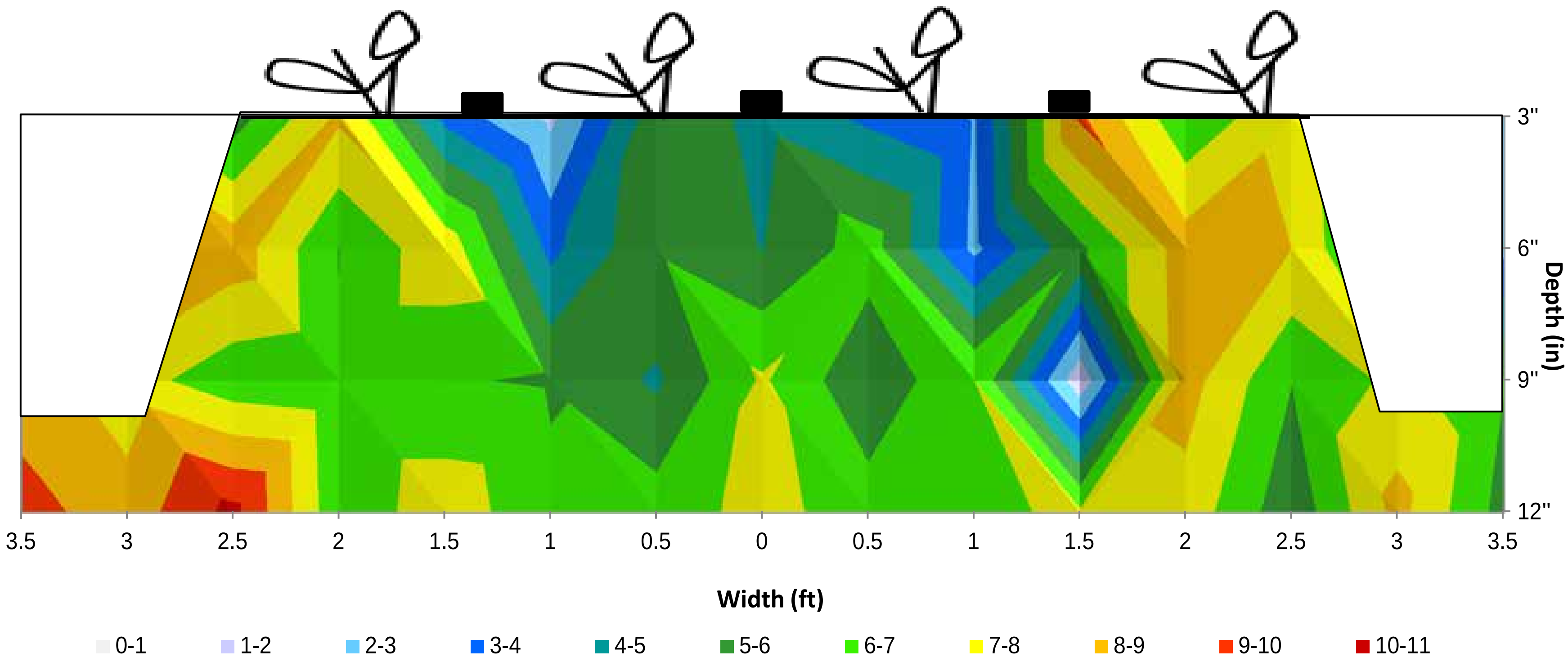
Eclipse	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	10.29	8.55	3.4	7.07	8.19	10.91	7.55	10.96	8.77	8.04	15.6	13.8	11.44	x
Temperature (F)	x	84.7	86.4	86.7	87.1	87.1	86.2	85.1	85.5	85.1	84.4	84.4	84.7	88.7	x
% Moisture	x	26.3	26.4	24.3	22.5	18.0	27.7	22.6	25.5	25.2	25.0	21.6	21.8	23.1	x



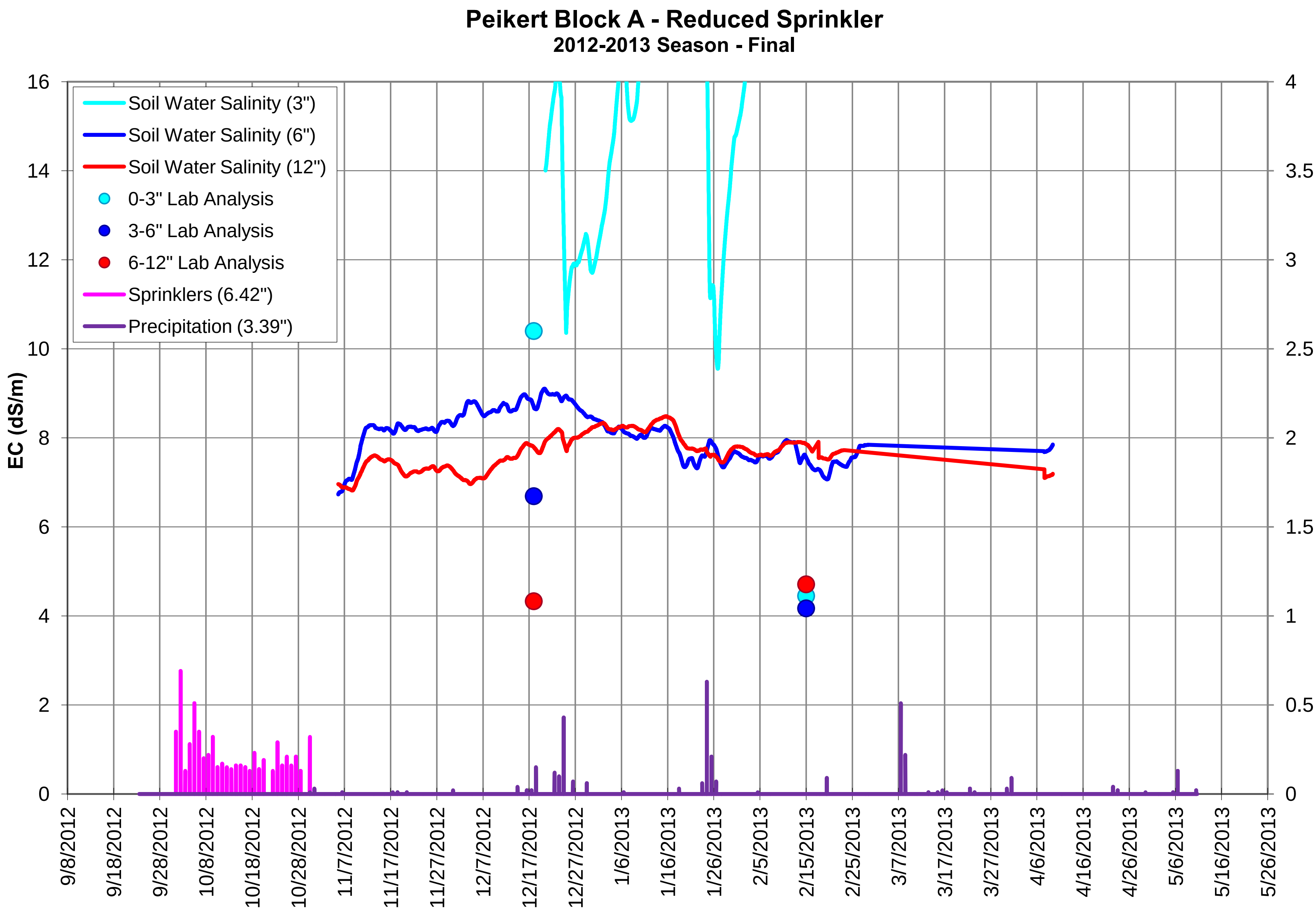
Eclipse Reduced Sprinkler - 3 Tape
EC (dS/m) 12/18/12
Average EC 13.82 dS/m
3"
6"
9"
12"
Depth (in)
3.5 3 2.5 2 1.5 1 0.5 0 0.5 1 1.5 2 2.5 3 3.5
Width (ft)
0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11

Eclipse Reduced Sprinkler - 3 Tape
EC (dS/m) 2/15/13

Average EC 6.20 dS/m



Peikert



Peikert Block A - Reduced Sprinkler
2012-2013 Season - Final
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (6.42")
Precipitation (3.39")
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012
12/7/2012
12/17/2012
12/27/2012
1/6/2013
1/16/2013
1/26/2013
2/5/2013
2/15/2013
2/25/2013
3/7/2013
3/17/2013
3/27/2013
4/6/2013
4/16/2013
4/26/2013
5/6/2013
5/16/2013
5/26/2013

Peikert – Block A

Irrigation Method: Reduced Sprinkler **Plant Date: 10/8/2012**


9/23/2012 – (-15) DAP


11/4/2012 – 27 DAP


12/19/2012 – 72 DAP


1/13/2013 – 97 DAP


2/15/2013 – 130 DAP


4/6/2013 – 180 DAP

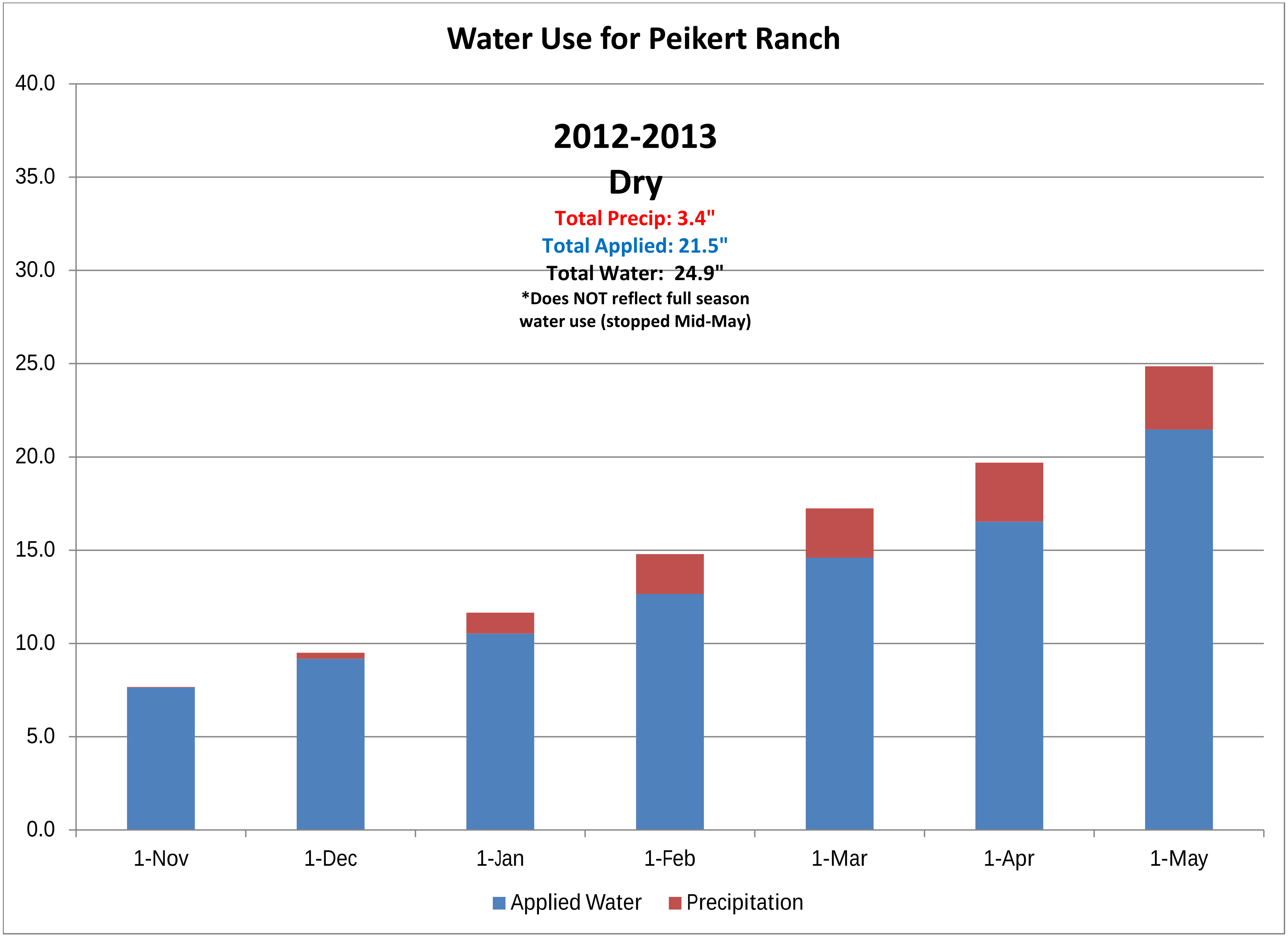
Peikert – Block A

Irrigation Method: Reduced Sprinkler **Plant Date: 10/8/2012**

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Peikert Blocks

	Date:	12/18/2012		2/15/2013							
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	10.40	962.50	4.45	162.40						
	3-6"	6.69	416.50	4.17	126.70						
	6-12"	4.33	130.20	4.71	170.10						

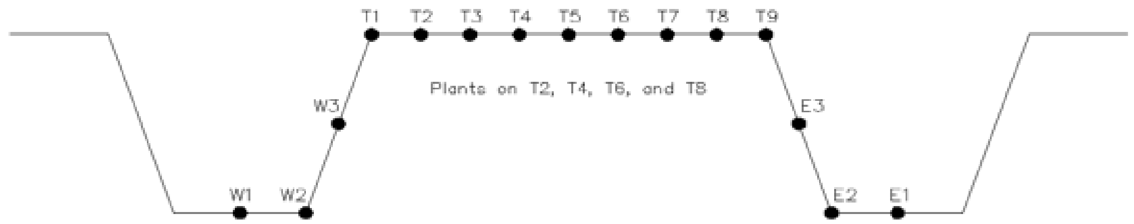
Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler


Water Use for Peikert Ranch
2012-2013
Dry
Total Precip: 3.4"
Total Applied: 21.5"
Total Water: 24.9"
*Does NOT reflect full season
water use (stopped Mid-May)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
Applied Water
Precipitation

Shallow Soil Analysis(Topo) - Top 3 inches
Piekert Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Piekert **11/4/2012**

Peikert	West													East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	X	7.7	3.93	1.68	6.57	19.2	13.28	17.98	16.75	9.72	12.4	11.46	6.18	3.02	X
Temperature (F)	X	86.2	85.8	85.5	86.2	85	85.5	84.9	84.6	84.4	84.7	85.1	85.6	85.8	X
% Moisture	X	23.9	25.2	16.4	22.4	24.7	20.6	23	17.4	25.3	21.8	21.8	23.5	21.8	X

Piekert **12/19/2012**

Peikert	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	X	3.9	10.99	1.98	5.57	9.04	6.31	8.17	6.48	10.3	6.91	1.57	10.59	1.95	17.32
Temperature (F)	X	61.3	60.8	60.3	59.9	59.7	59.7	59.9	59.7	59.2	59	58.5	58.8	59.4	59.5
% Moisture	X	19.7	16.1	18.3	21.3	21.8	22.8	22.2	23.3	22.7	18.9	19	21.1	22.2	23.8

Piekert **1/13/2013**

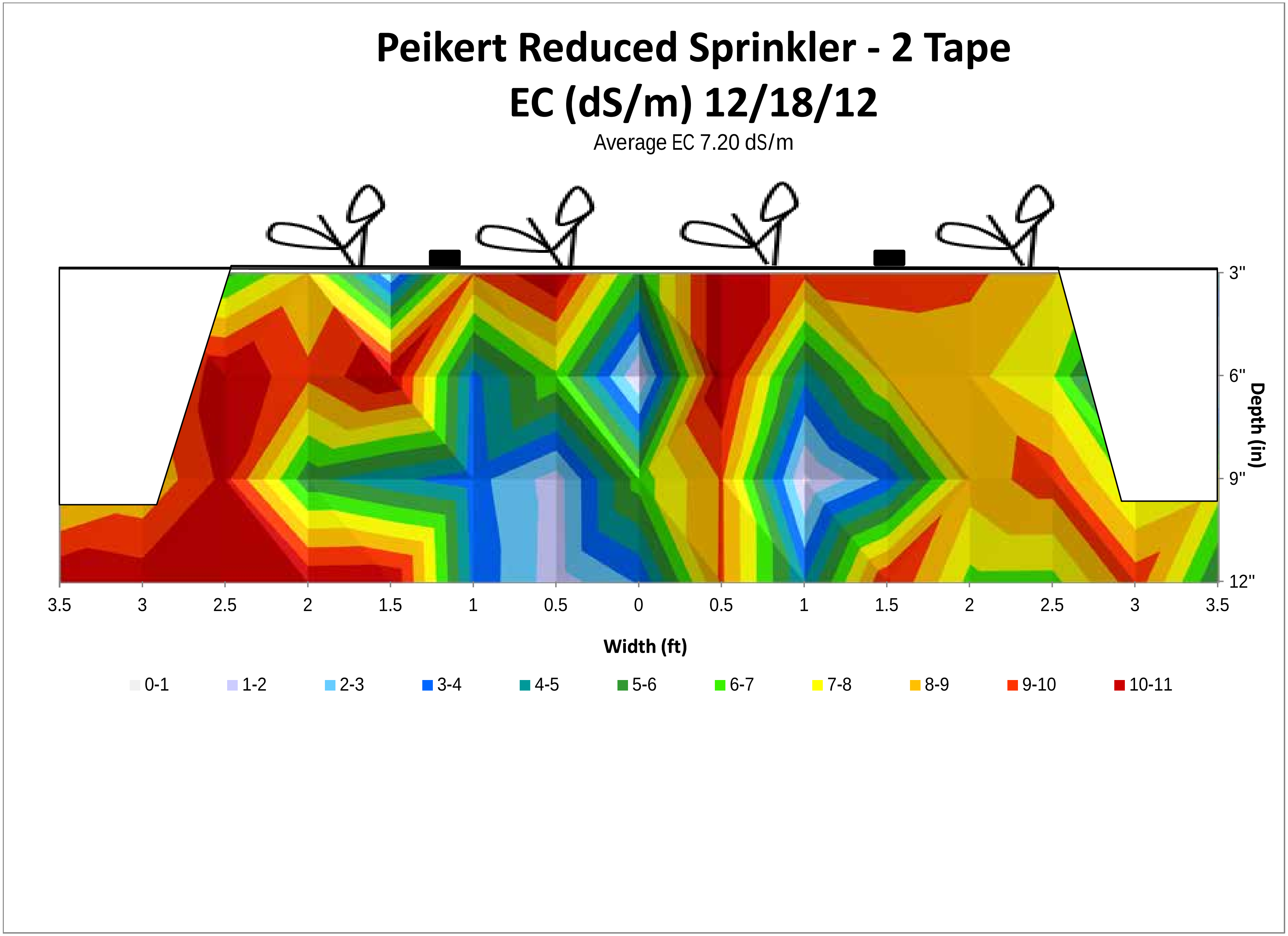
Peikert	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	7.81	7.83	6.14	4.99	4.19	7.38	7.28	10.8	4	6.94	5.19	2.56	8.09	x
Temperature (F)	x	53.8	54.1	55.2	54.5	51.8	51.1	52.3	52.9	52.9	52	51.4	50.4	49.8	x
% Moisture	x	24.6	25	25.9	23.8	24.3	22.1	23.7	23.1	29.9	22.1	24.1	23.6	23.9	x

Piekert **2/15/2013**

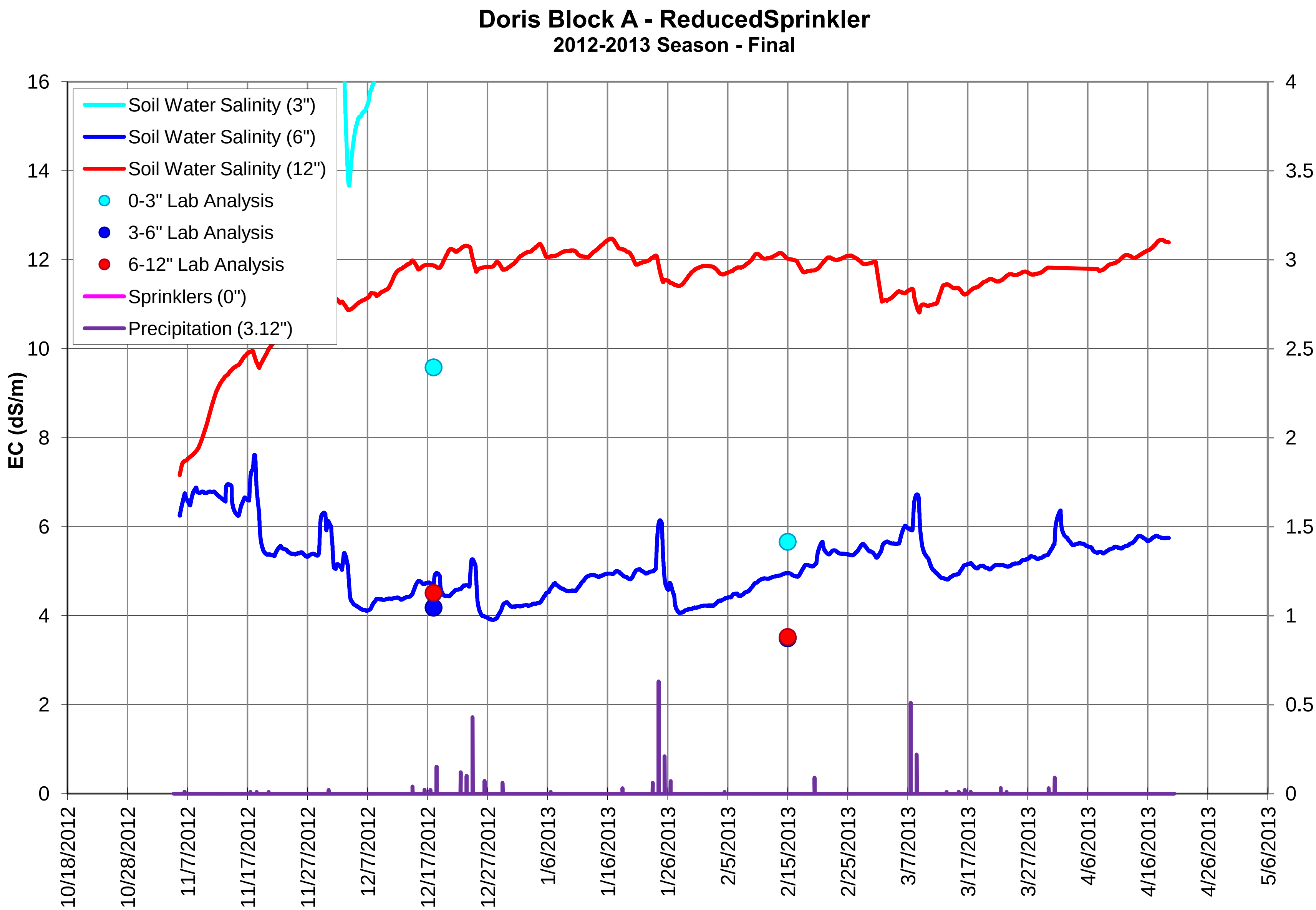
Peikert	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	3.84	7.7	4.21	6.81	8.54	5.54	8.78	7.43	6.06	6.51	4.25	7.27	9.63	x
Temperature (F)	x	74.8	74.5	74.5	73.2	73.0	54.1	74.1	74.1	73.6	73.9	74.1	74.3	74.3	x
% Moisture	x	29.0	22.5	21.1	41.0	24.1	29.6	30.5	24.0	27.1	20.5	19.1	27.5	25.3	x

Piekert **4/6/2013**

Peikert	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	14.48	10.2	3.74	9.63	10.22	7.04	6.48	7.21	4.44	6.86	7.95	6.41	9.35	x
Temperature (F)	x	78.8	78.4	79.0	79.7	79.9	80.1	80.4	81.0	81.0	81.3	82.0	82.2	82.8	x
% Moisture	x	21.5	18.0	14.7	21.7	20.3	19.1	20.8	19.8	19.3	19.1	19.3	17.5	19.6	x


Peikert Reduced Sprinkler - 2 Tape
EC (dS/m) 12/18/12
Average EC 7.20 dS/m
3"
6"
9"
12"
Depth (in)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Width (ft)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11

Doris


Doris Block A - ReducedSprinkler
2012-2013 Season - Final
EC (dS/m)
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (3.12")
0
2
4
6
8
10
12
14
16
0
0.5
1
1.5
2
2.5
3
3.5
4
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012
12/7/2012
12/17/2012
12/27/2012
1/6/2013
1/16/2013
1/26/2013
2/5/2013
2/15/2013
2/25/2013
3/7/2013
3/17/2013
3/27/2013
4/6/2013
4/16/2013
4/26/2013
5/6/2013

Doris – Block A

Irrigation Method: Reduced Sprinkler **Plant Date: 10/5/2012**

11/4/2012 - 30 DAP

12/18/2012 – 74 DAP

1/13/2013 – 100 DAP

2/15/2013 – 133 DAP

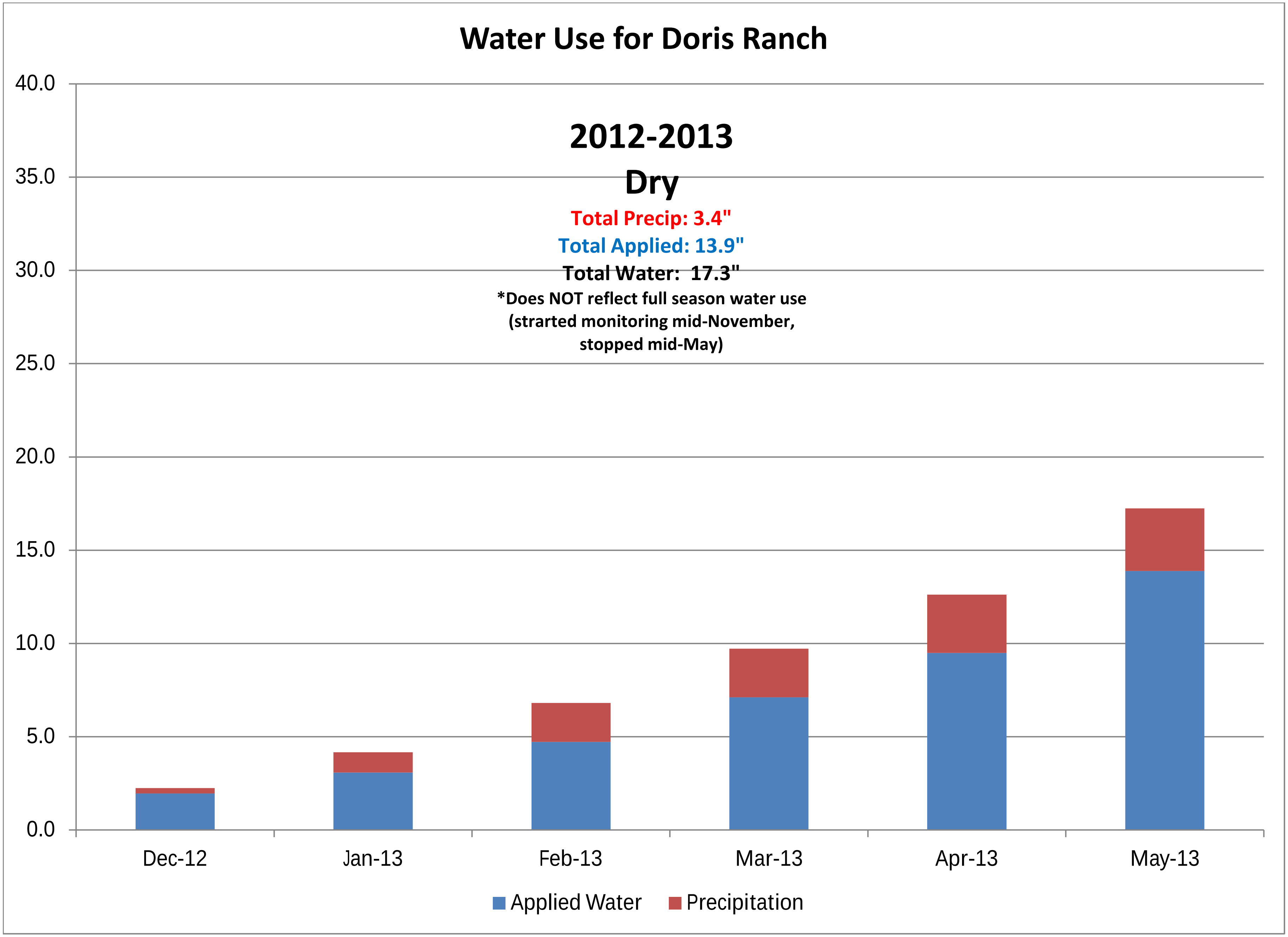
4/6/2013 – 183 DAP

5/10/2013 – 217 DAP

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Doris Blocks

Date:		12/18/2013		2/15/2013							
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	9.58	728.00	5.66	72.80						
	3-6"	4.18	123.90	3.49	32.90						
	6-12"	4.51	142.10	3.52	40.60						

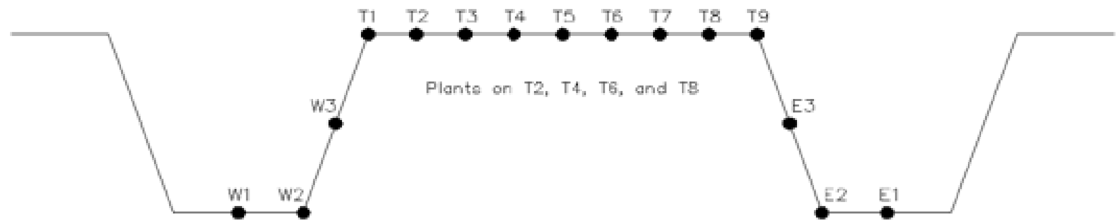
Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler


Water Use for Doris Ranch
2012-2013
Dry
Total Precip: 3.4"
Total Applied: 13.9"
Total Water: 17.3"
*Does NOT reflect full season water use
(strarted monitoring mid-November,
stopped mid-May)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
Applied Water
Precipitation

Shallow Soil Analysis(Topo) - Top 3 inches
Doris Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Doris **11/4/2012**

Doris	West													East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	0.3	4.7	15.0	7.4	13.2	13.4	12.2	12.0	11.8	19.9	16.4	12.5	16.4	14.1	16.9
Temperature (F)	74.1	73.6	73.4	73.2	72.9	72.5	72.5	72.3	72.3	72.1	72.0	71.8	72.1	72.7	73.2
% Moisture	17.0	20.1	22.0	17.3	20.4	18.4	19.6	16.1	18.9	15.1	21.0	17.9	20.8	19.2	22.9

Doris **12/18/2012**

Doris	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	7.7	3.0	3.7	2.0	3.7	6.5	4.2	20.1	6.7	7.6	6.4	7.6	12.4	12.6	X
Temperature (F)	61.7	61.0	60.8	61.3	62.4	62.2	62.1	61.3	61.2	59.5	59.5	59.5	59.7	59.7	X
% Moisture	21.8	19.8	16.4	16.7	19.9	13.6	18.6	20.1	18.2	18.3	19.5	21.8	17.0	24.1	X

Doris **1/13/2013**

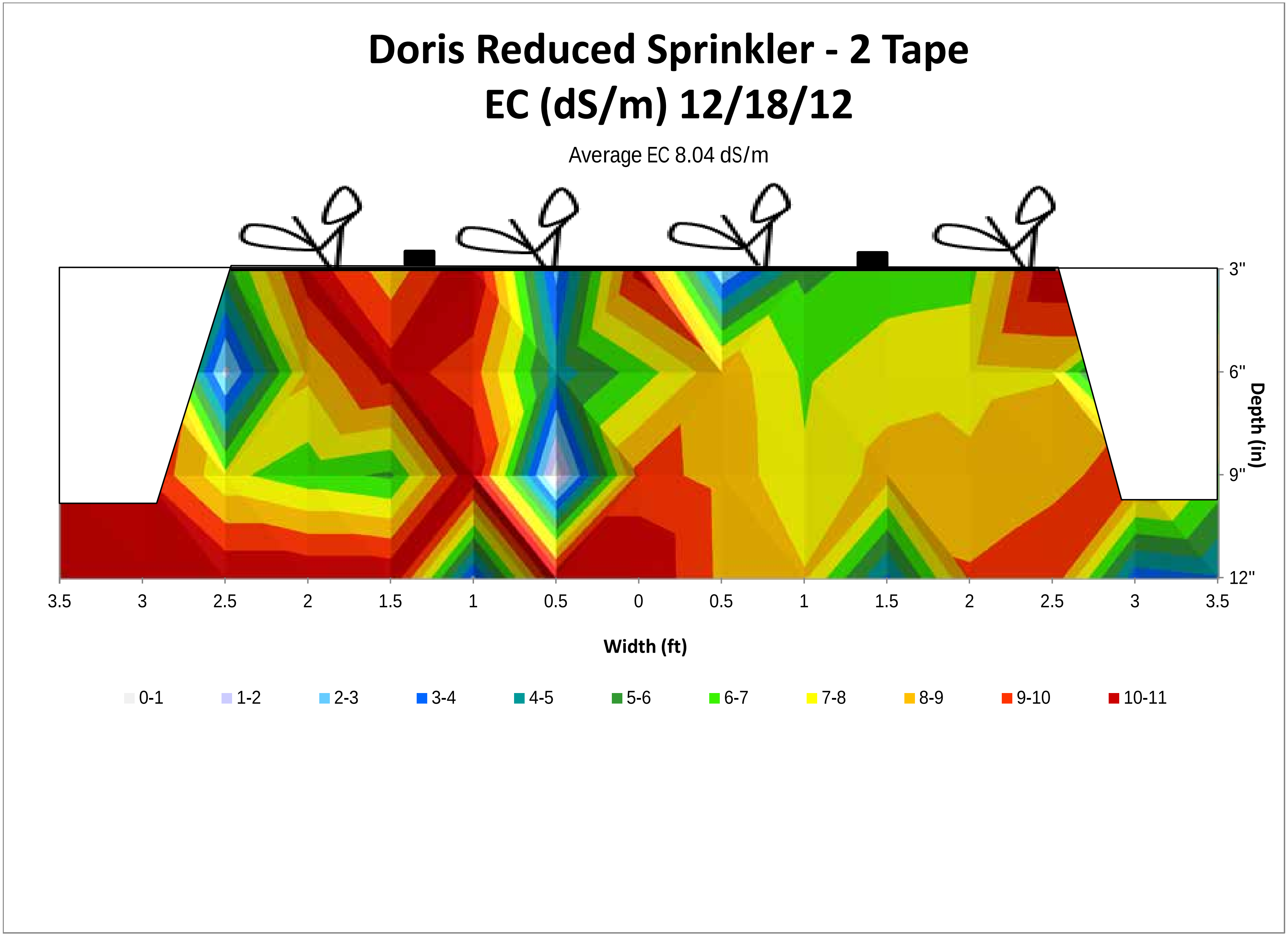
Doris	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	3.21	3.13	2.06	3.8	4.94	10.23	13.4	6.52	4.38	4.8	9.45	8.78	2.15	x
Temperature (F)	x	67.6	68.4	65.5	64.2	63.9	63.5	62.6	61.3	61.3	60.4	58.8	59.2	59.7	x
% Moisture	x	24.7	21.3	22.3	20.9	24.4	21.2	22.7	23.9	23.9	23.3	21.1	18.0	24.4	x

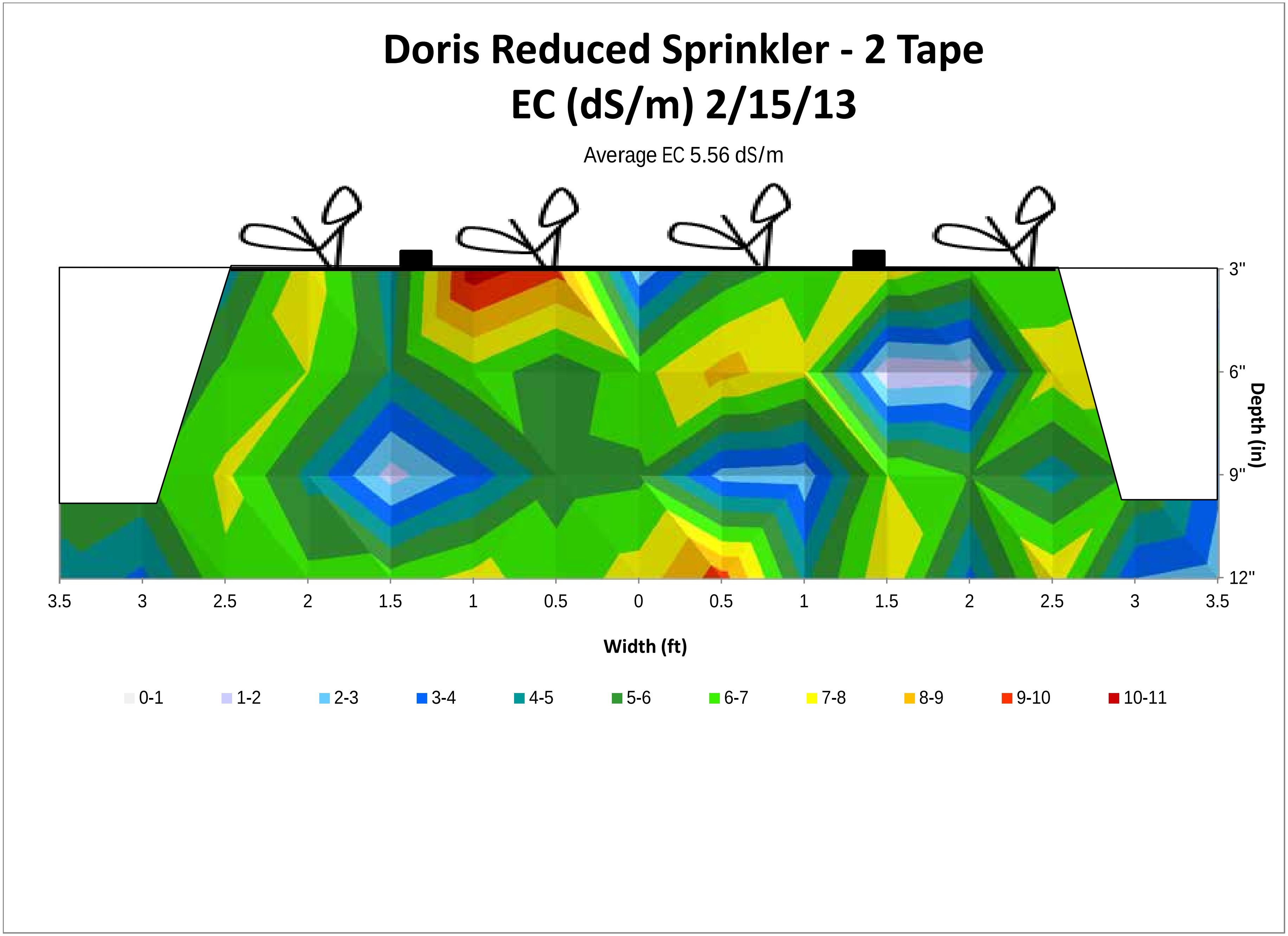
Doris **2/15/2013**

Doris	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	4.66	5.06	6.18	5.59	8.26	3.25	16.2	10.88	3.44	13.32	2.55	4.37	2.29	x
Temperature (F)	x	75.0	74.7	73.9	73.2	72.7	72.9	72.3	72.7	73.2	73.4	74.7	77.4	77.4	x
% Moisture	x	26.9	22.9	19.7	20.3	20.7	22.0	22.7	17.7	22.5	19.8	20.9	25.8	25.1	x

Doris **4/6/2013**

Doris	West														East
	W1	W2	W3	T1	T2	T3	T4	T5	T6	T7	T8	T9	E3	E2	E1
Salinity (dS/m)	x	4.5	4.53	6.03	3.29	7.8	13.1	17.6	15.3	8.09	12.87	7.76	12.1	9.18	x
Temperature (F)	x	79.0	80.1	80.6	80.2	79.0	78.1	77.4	77.2	75.9	75.6	75.9	75.9	75.7	x
% Moisture	x	21.4	23.6	20.1	22.5	13.2	18.0	20.4	22.1	27.3	19.0	16.7	19.9	21.7	x

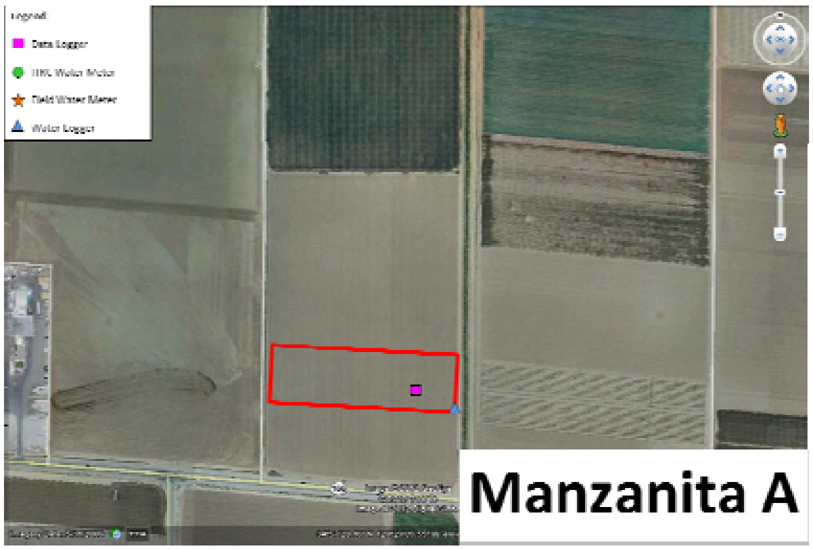

Doris Reduced Sprinkler - 2 Tape
EC (dS/m) 12/18/12
Average EC 8.04 dS/m
3"
6"
9"
12"
Depth (in)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Width (ft)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11

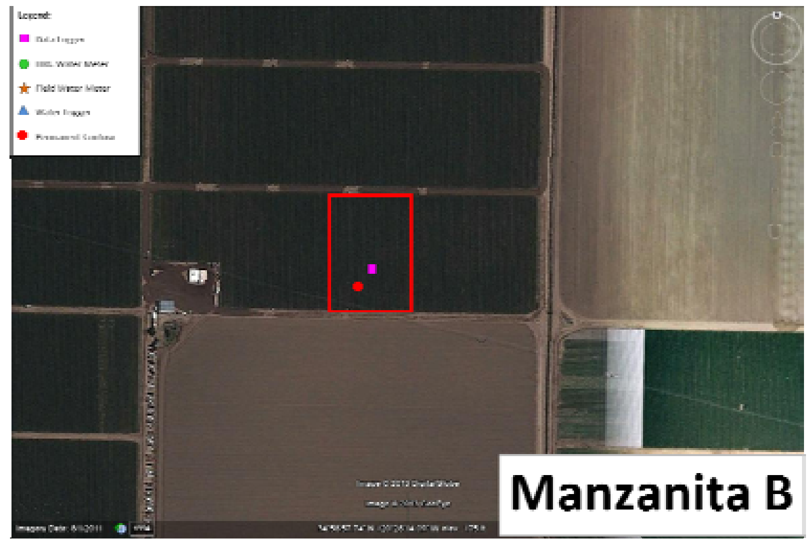


Doris Reduced Sprinkler - 2 Tape
EC (dS/m) 2/15/13
Average EC 5.56 dS/m
3"
6"
9"
12"
Depth (in)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Width (ft)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11

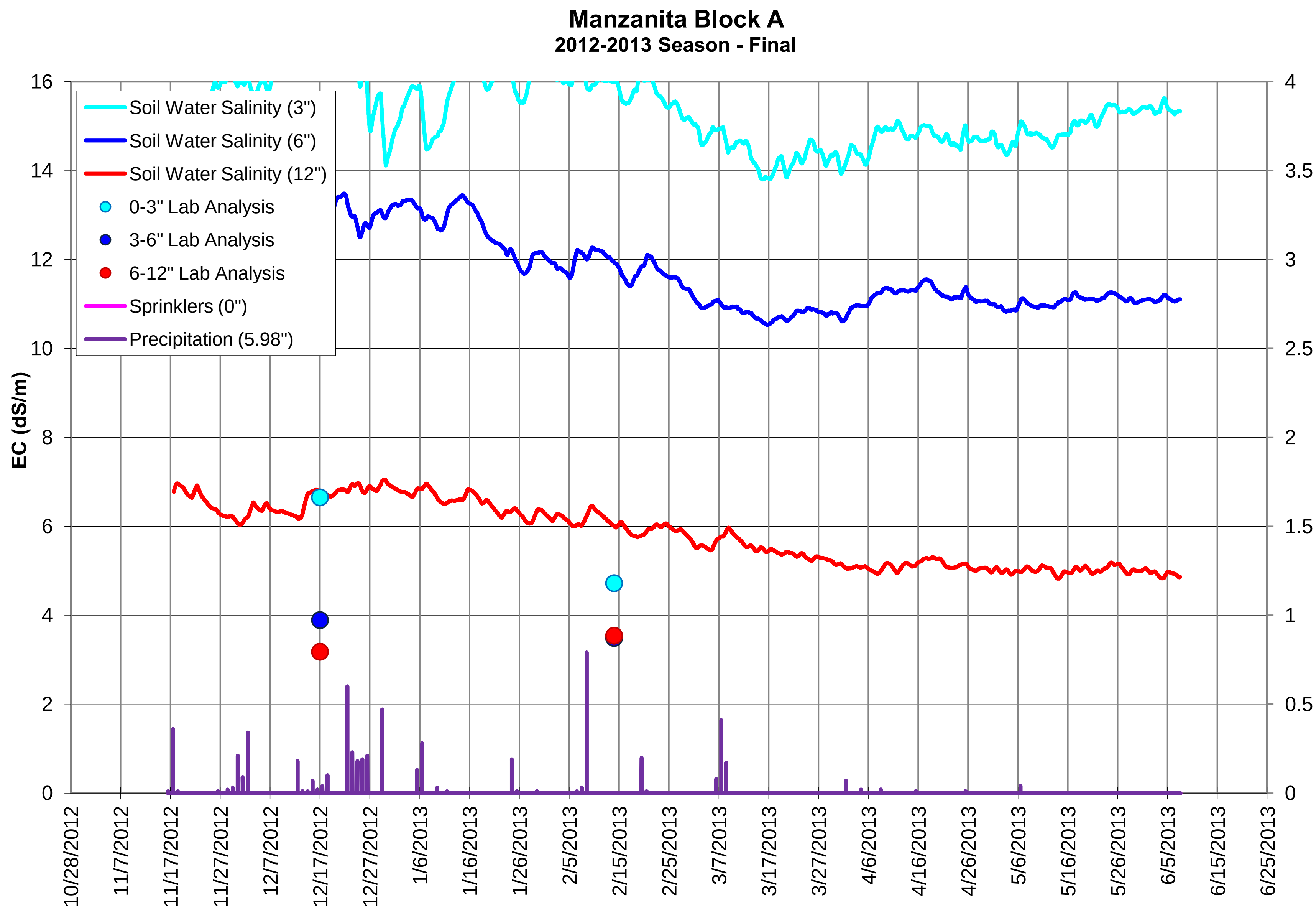
Santa Maria
Blocks
2012-2013

Santa Maria Area





Manzanita

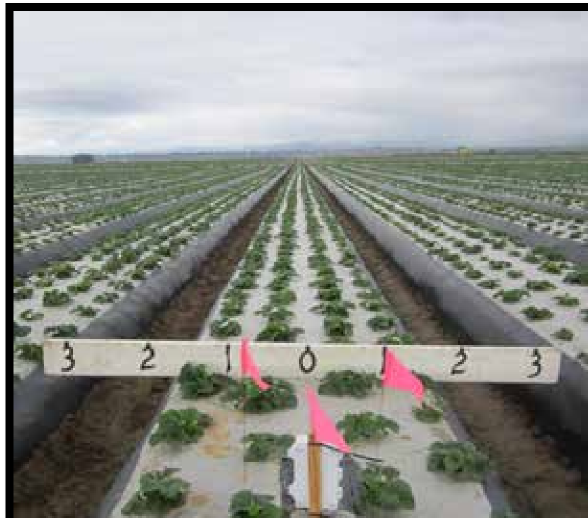


Manzanita Block A
2012-2013 Season - Final
EC (dS/m)
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (5.98")
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
10/28/2012
11/7/2012
11/17/2012
11/27/2012
12/7/2012
12/17/2012
12/27/2012
1/6/2013
1/16/2013
1/26/2013
2/5/2013
2/15/2013
2/25/2013
3/7/2013
3/17/2013
3/27/2013
4/6/2013
4/16/2013
4/26/2013
5/6/2013
5/16/2013
5/26/2013
6/5/2013
6/15/2013
6/25/2013

Manzanita – Block A

Irrigation Method: Reduced Sprinkler **Plant Date: 10/8/2012**

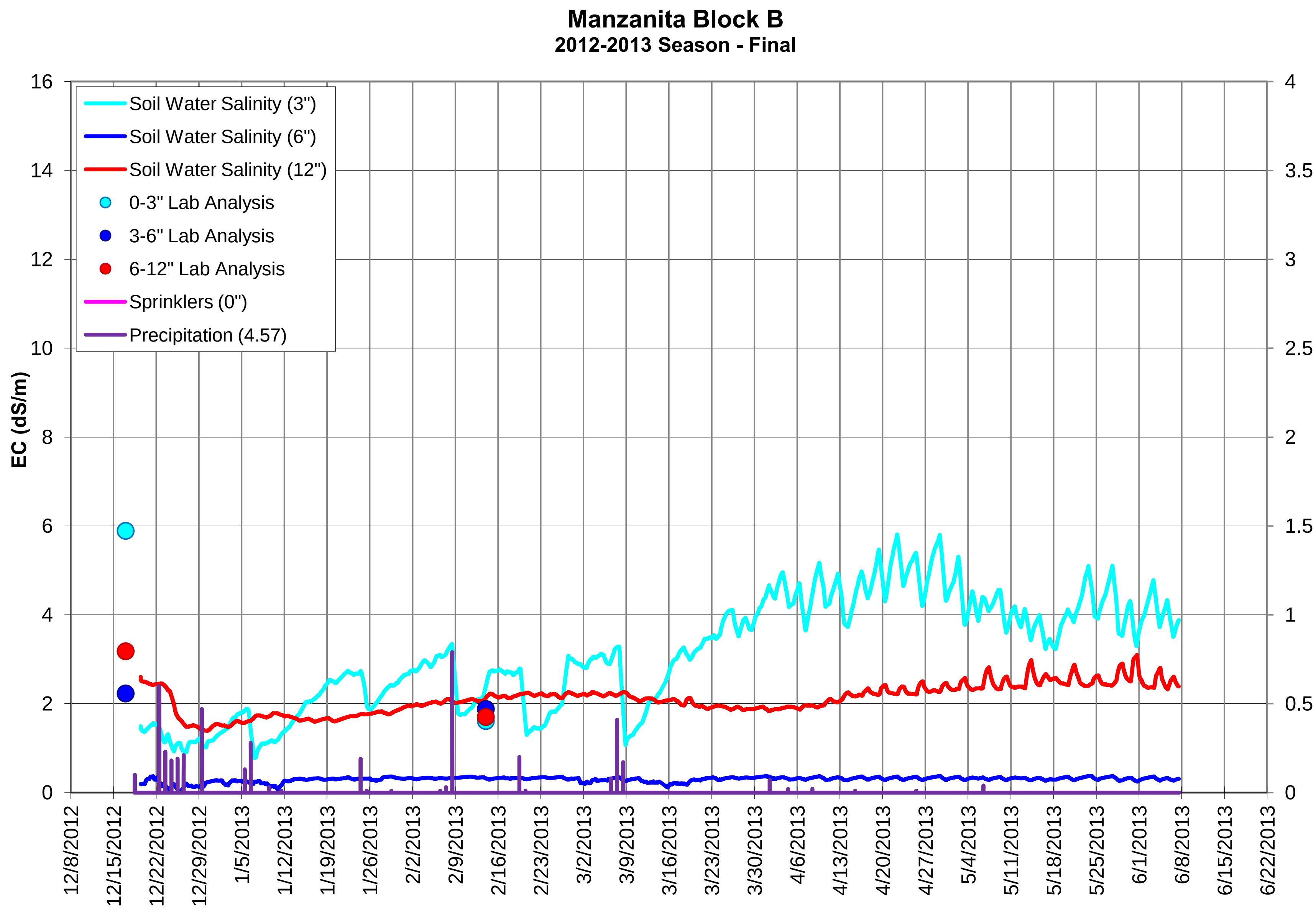
11/16/2012 – 39 DAP



12/17/2012 – 70 DAP

1/13/2013 – 97 DAP

3/14/2013 – 157 DAP


Manzanita Block B
2012-2013 Season - Final
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (4.57)
12/8/2012
12/15/2012
12/22/2012
12/29/2012
1/5/2013
1/12/2013
1/19/2013
1/26/2013
2/2/2013
2/9/2013
2/16/2013
2/23/2013
3/2/2013
3/9/2013
3/16/2013
3/23/2013
3/30/2013
4/6/2013
4/13/2013
4/20/2013
4/27/2013
5/4/2013
5/11/2013
5/18/2013
5/25/2013
6/1/2013
6/8/2013
6/15/2013
6/22/2013

Manzanita – Block B

Irrigation Method: Reduced Sprinkler **Plant Date: 11/21/2012**

12/18/2012 – 27 DAP

1/10/2013 – 50 DAP

2/23/2013 – 94 DAP

3/14/2013 – 113 DAP

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Manzanita Blocks

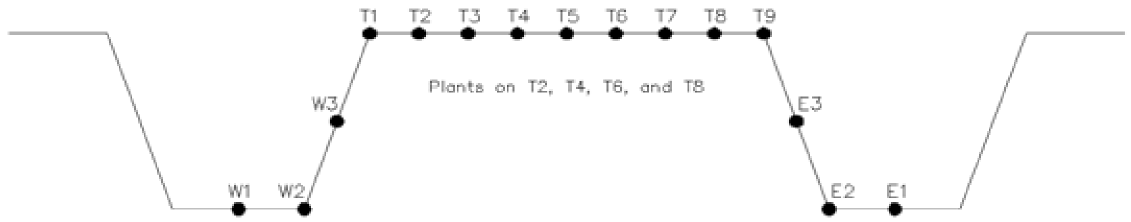
Date:		12/17/2012		2/15/2013							
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	6.65	43.05	4.72	76.30						
	3-6"	3.89	129.50	3.49	30.80						
	6-12"	3.18	111.30	3.54	32.90						
Block B	0-3"	5.89	595.00	1.61	41.65						
	3-6"	2.23	66.15	1.88	39.90						
	6-12"	3.18	98.70	1.70	30.80						

Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler

Shallow Soil Analysis(Topo) - Top 3 inches
Manzanita Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Block A **11/16/2012**

Manzanita	West													East
Block A	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	X	5.44	3.81	5.8	1.16	3.83	3.99	6.85	1.34	3.61	2.03	4.47	4.31	5.29	X
Temperature (F)	X	68.5	68.5	69.1	70.2	69.8	69.3	69.9	68.7	68.5	67.8	66.9	66.9	66.6	X
% Moisture	X	27.7	24.2	20	19.1	26.2	29.9	24.4	14.3	27.7	20.1	23.6	33.1	27.8	X

Block A **12/17/2012**

Manzanita	West														East
Block A	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	13.23	12.77	11.98	11.34	7.76	5.56	4.79	10.19	8.19	6.75	1.85	4.49	6	11.27	7.91
Temperature (F)	61.2	61.4	61.5	61.9	62.6	62.8	63	63.1	63.3	63.5	63.7	63.7	64	64	63.5
% Moisture	22.1	21.3	19.5	19.7	23.4	27.2	24.6	23.4	23.4	24.8	27	22.3	27.5	27.6	24.7

Block A **1/10/2013**

Manzanita	West														East
Block A	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	11.51	4.21	7.59	6.2	3.53	3.6	3.92	12.89	3.18	2.88	4.27	7.1	6.51	6.68	9.74
Temperature (F)	54.9	54.7	55.6	55.6	55.2	55.6	55.8	56.7	57.6	57.2	56.1	55.6	55.8	55.4	54.7
% Moisture	22.1	22.8	23.4	21.7	22.2	20.9	19.9	24.3	24.6	24.1	25.4	24.3	25.8	21.1	22.4

Block A **2/15/2013**

Manzanita	West														East
Block A	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	x	1.54	4.57	2.75	1.32	6.22	2.11	12.43	4.75	3.28	5.71	3.92	5.28	6.36	x
Temperature (F)	x	79.3	78.7	79	77.5	77.4	77.4	76.8	75.7	75	74.1	73.2	72.9	72.5	x
% Moisture	x	19.3	19.9	13.6	18	17.7	22.5	24.2	22	22.6	15.8	17	22.6	26.8	x

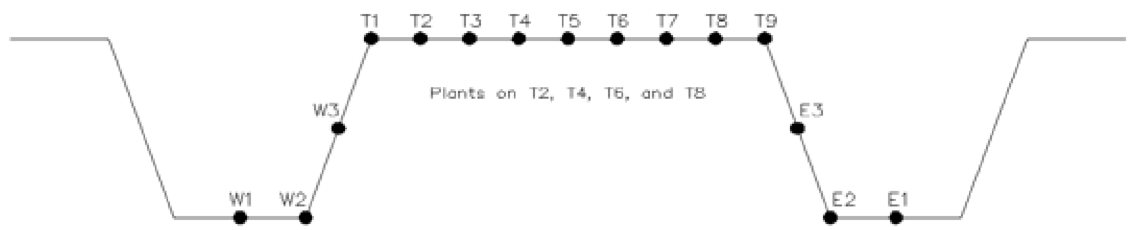
Block A **3/14/2013**

Manzanita	West														East
Block A	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	x	3.76	4.27	3.61	2.89	5.07	4.66	14.32	4.75	12.09	3.09	8.66	5.51	5.62	x
Temperature (F)	x	81.5	80.4	79.7	78.7	78.4	78.1	78.3	79.3	77.9	75	74.7	75.4	75.7	x
% Moisture	x	23.1	25.4	21.8	21.6	24	15.3	25.4	22.5	22.2	19.9	17.2	15.9	18.9	x

Shallow Soil Analysis(Topo) - Top 3 inches
Manzanita Strawberries

Using ProCheck and 5TE Sensor

= Salinity > 8



Block B **12/19/2012**

Manzanita	West	→												East
Block B	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	2.62	1.39	12.31	12.7	1.49	7.21	2.14	9.2	1.26	5.59	3.81	10.52	10.11	2.42	1.37
Temperature (F)	58.1	58.3	57.4	57.2	57.2	57.2	58.3	59.4	60.3	59.9	60.1	60.6	61.9	63.1	63.3
% Moisture	17.1	17.9	13.8	12.7	19.7	14.9	16.3	12.9	20.3	14.8	17.3	13.7	15.5	17.9	19.4

Block B **1/10/2013**

Manzanita	West	→												East
Block B	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	X	3.67	12.4	10.2	3.33	5.4	2.36	7.34	2.78	5.11	2.01	6.77	5.94	2.12	1.43
Temperature (F)	X	52.7	54.4	56.5	57	57	57	57	57.2	57	57	57	57	57	57
% Moisture	X	15.8	14.3	13.8	13.1	14.5	16.4	14.3	17.4	15.4	19.8	15.7	15.8	18.6	18.9

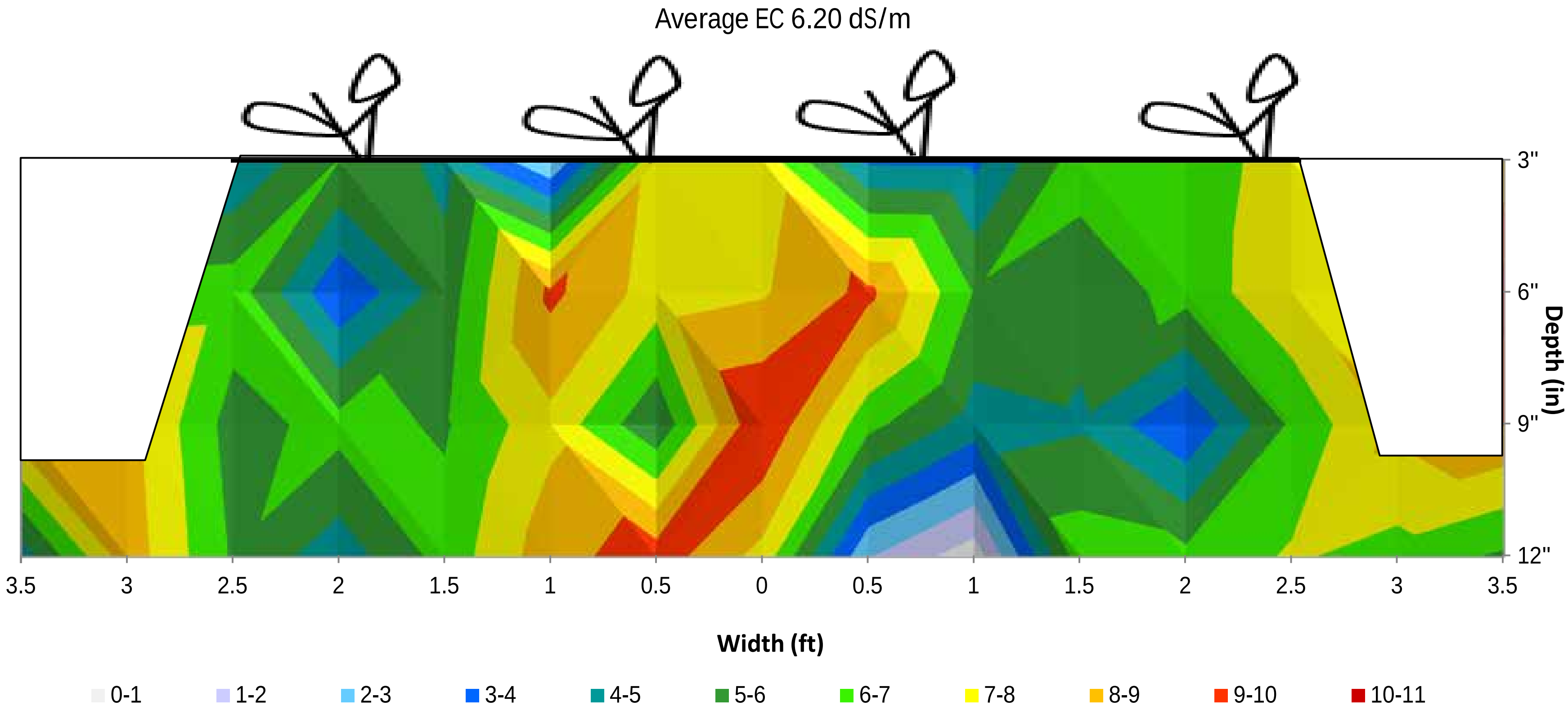
Block B **2/15/2013**

Manzanita	West	→												East
Block B	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	x	3.39	5.67	5.16	2.21	3.17	2.57	4.94	2.61	1.86	1.57	4.22	6.72	1.65	x
Temperature (F)	x	79	78.4	78.4	77.4	77.2	78.1	77.7	78.4	78.4	79.7	79.3	79	77.9	x
% Moisture	x	12.4	12.6	8.8	16.5	16.2	18.7	14.8	18	16.9	22.6	15.6	12.9	18.5	x

Block B **3/14/2013**

Manzanita	West	→												East
Block B	**W1**	**W2**	**W3**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**E3**	**E2**	**E1**
Salinity (dS/m)	x	x	4.62	x	0.48	2.59	2.65	9.28	2.33	4.79	7.81	5.16	5.77	1.92	x
Temperature (F)	x	x	78.8	x	74.1	73.9	75.2	79.9	80.6	77.7	78.6	78.6	80.1	80.1	x
% Moisture	x	x	13.1	x	14	15.1	16.1	12.2	18.2	14.8	11.5	12.7	12.1	18.7	x

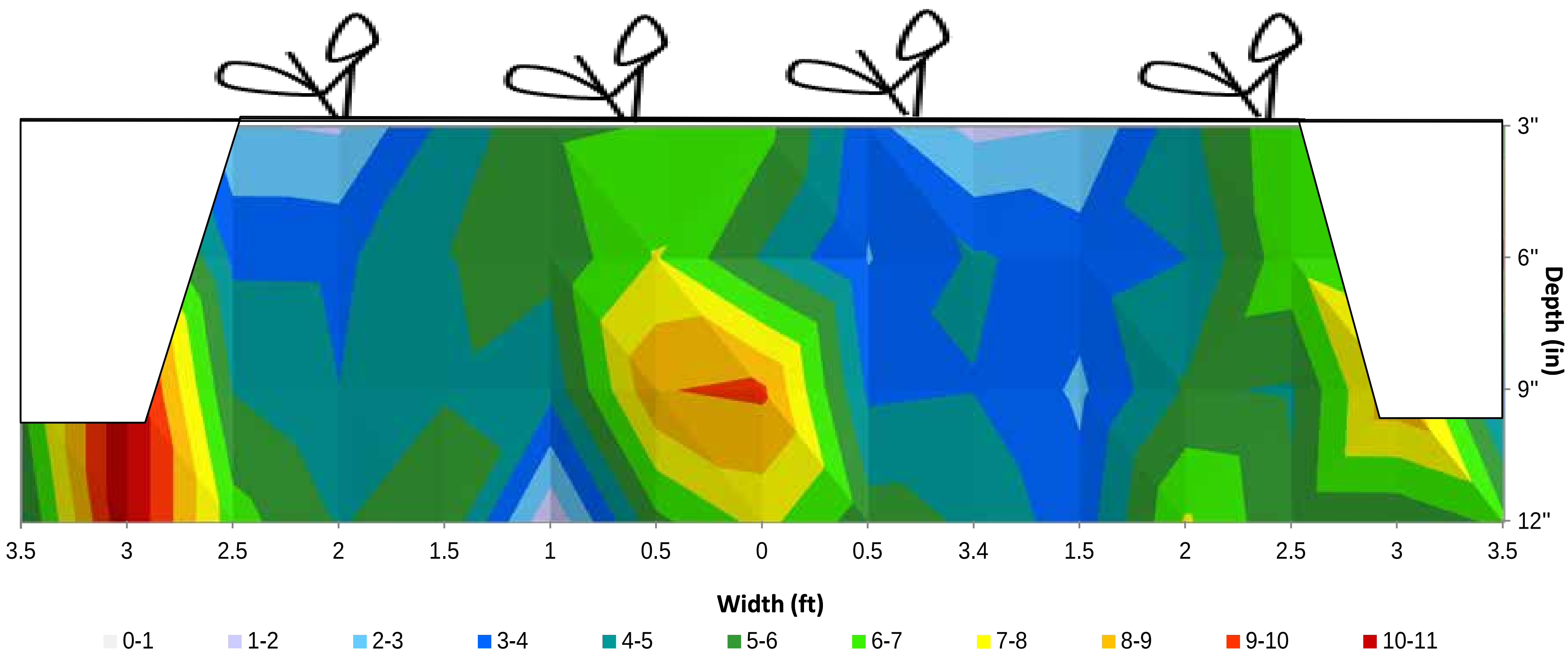
Manzanita A - Reduced Sprinkler
EC (dS/m) 12/17/12

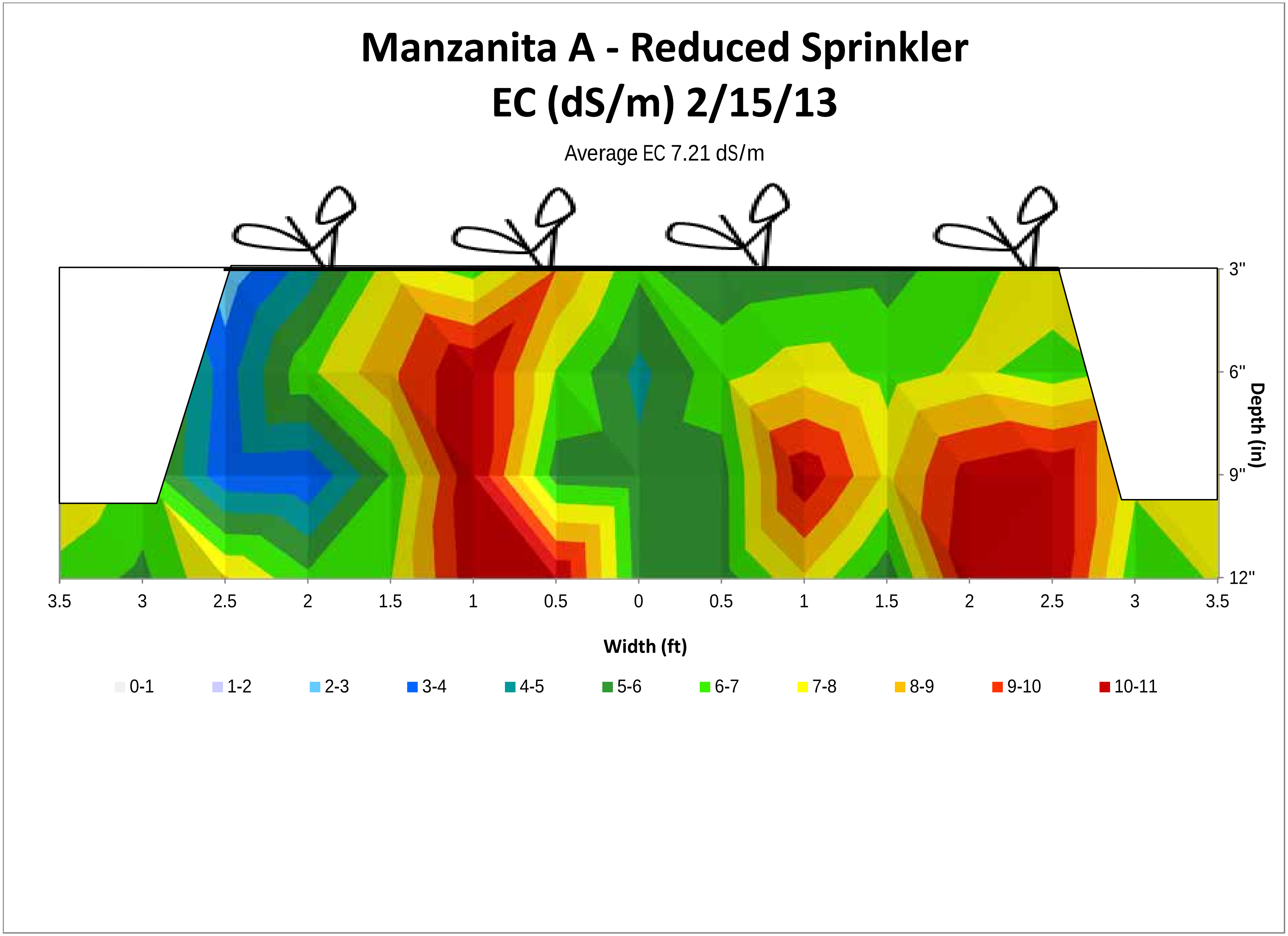


Manzanita B - Reduced Sprinkler

EC (dS/m) 12/18/12

Average EC 5.32 dS/m

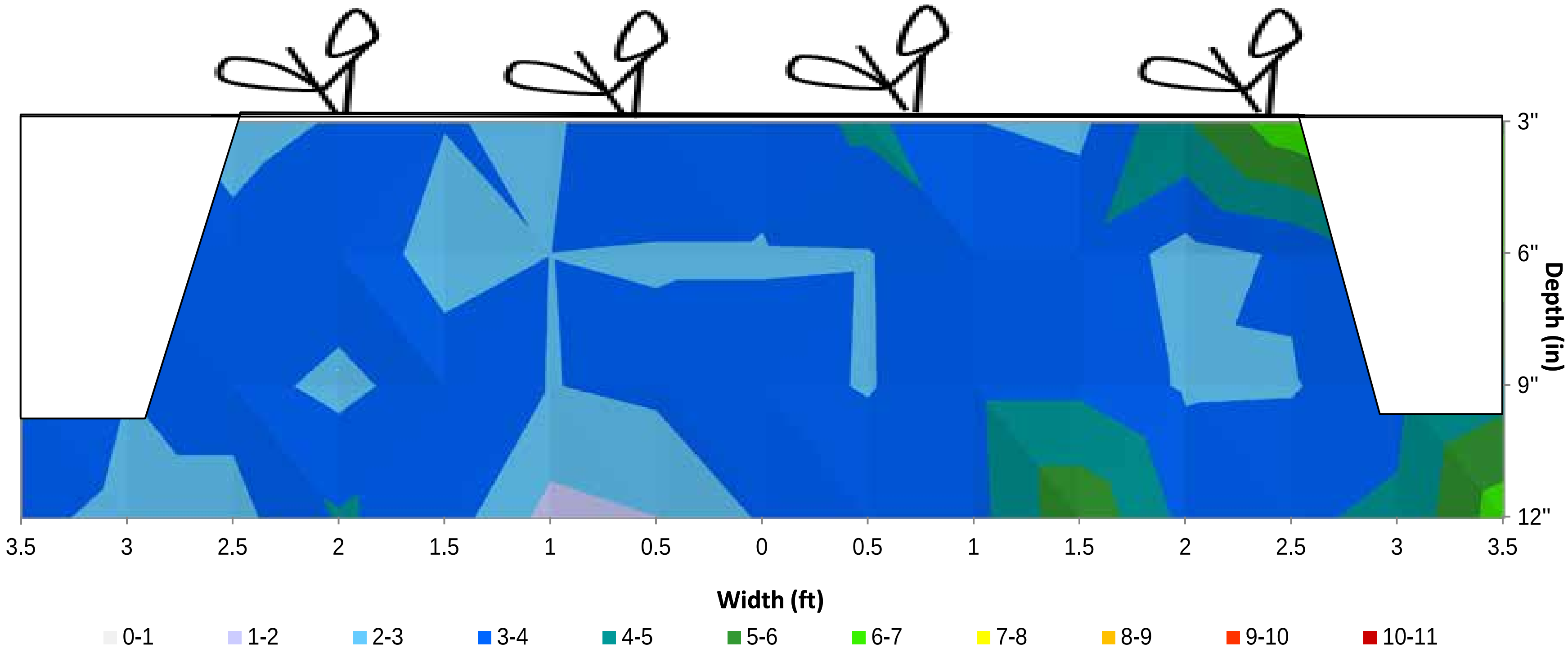




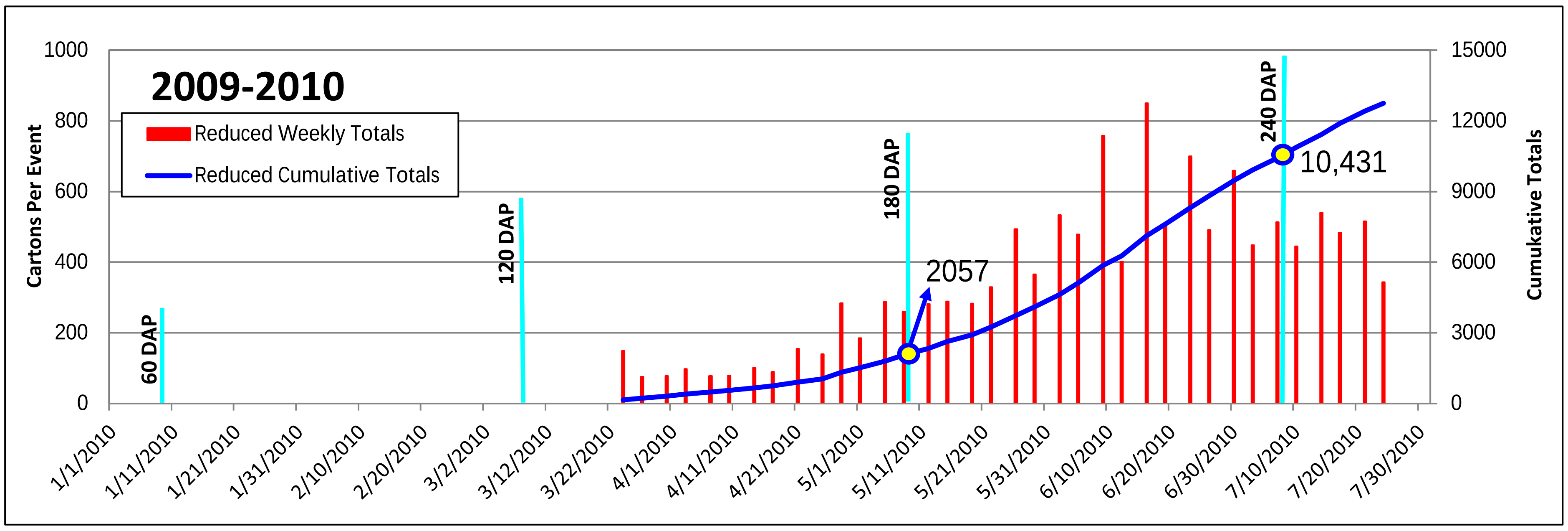
Manzanita A - Reduced Sprinkler
EC (dS/m) 2/15/13
Average EC 7.21 dS/m
3"
6"
9"
12"
Depth (in)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Width (ft)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11

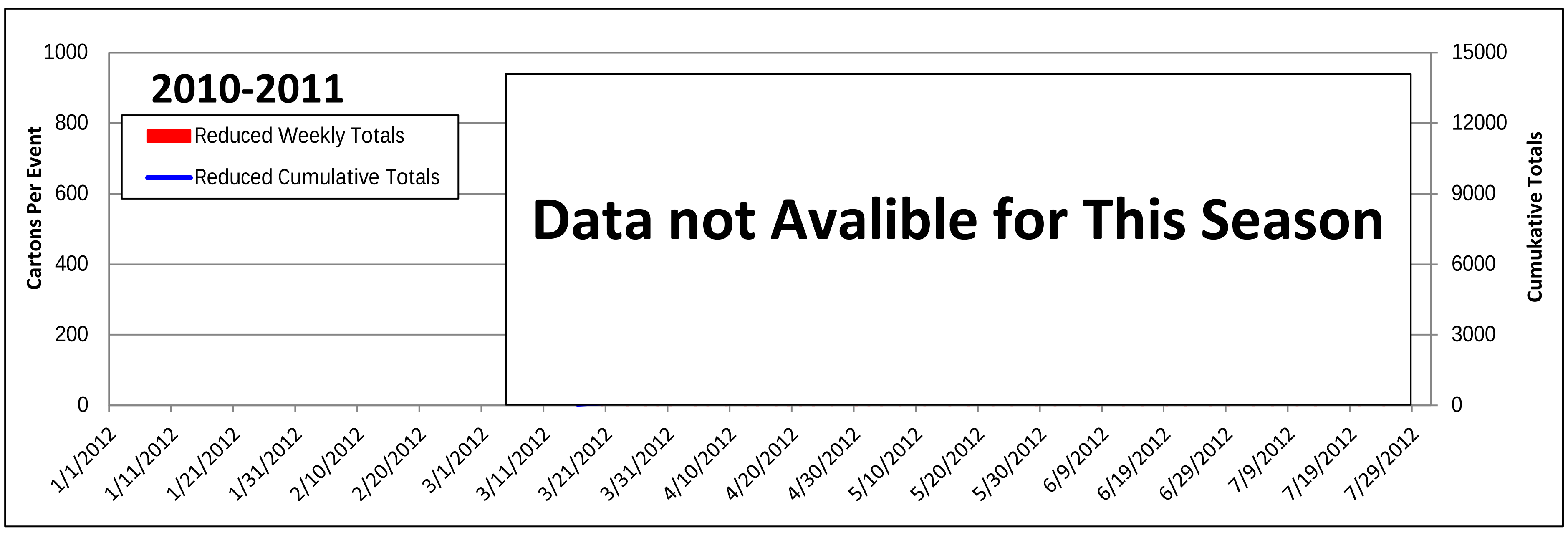
Manzanita B - Reduced Sprinkler
EC (dS/m) 2/15/13

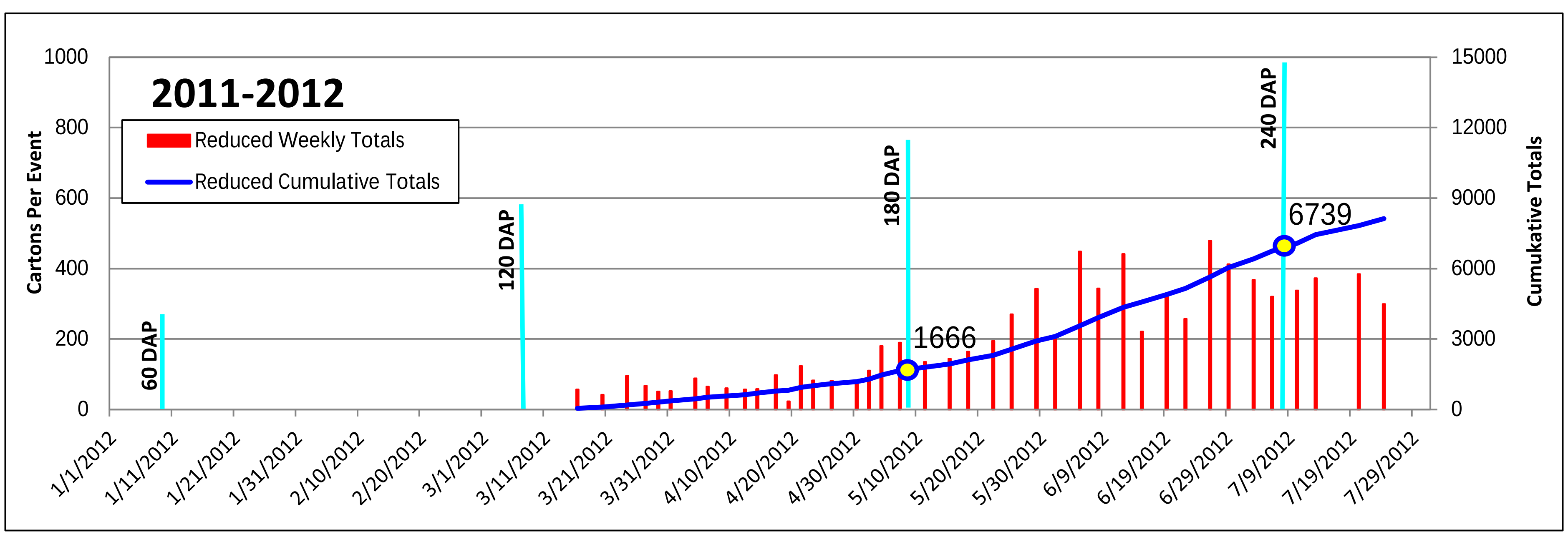
Average EC 3.62 dS/m

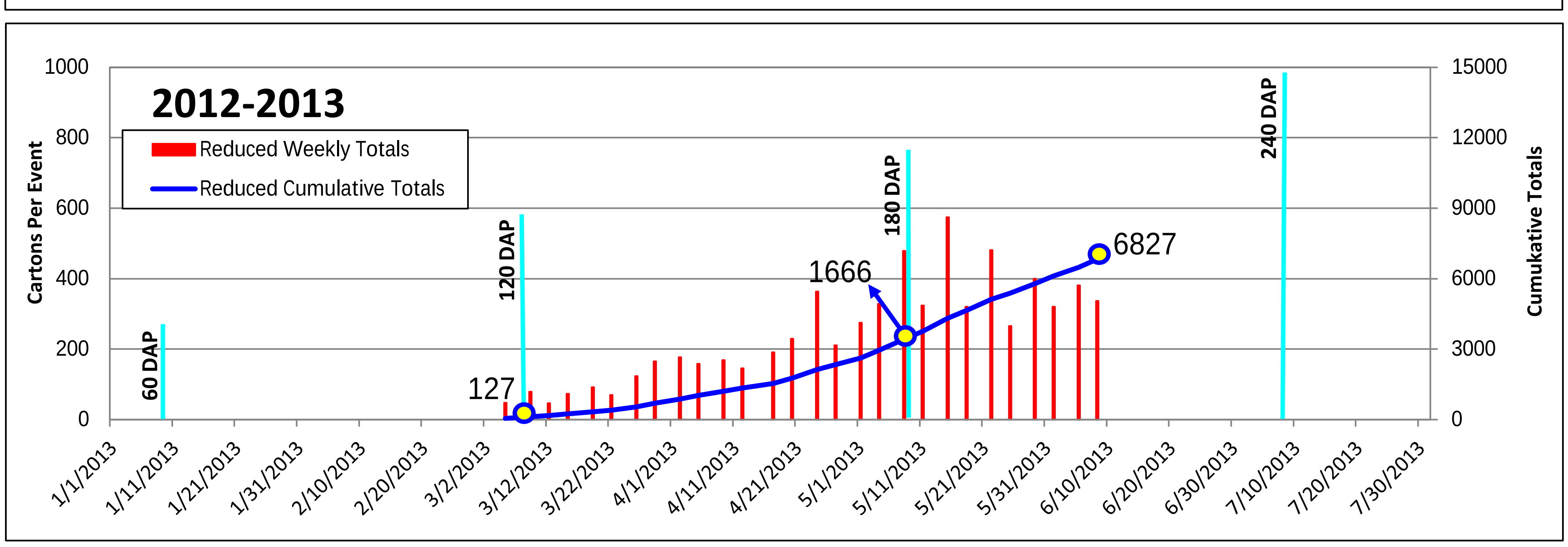


Manzanita Yield Data Comparison - Reduced Sprinkler, 2 Tape

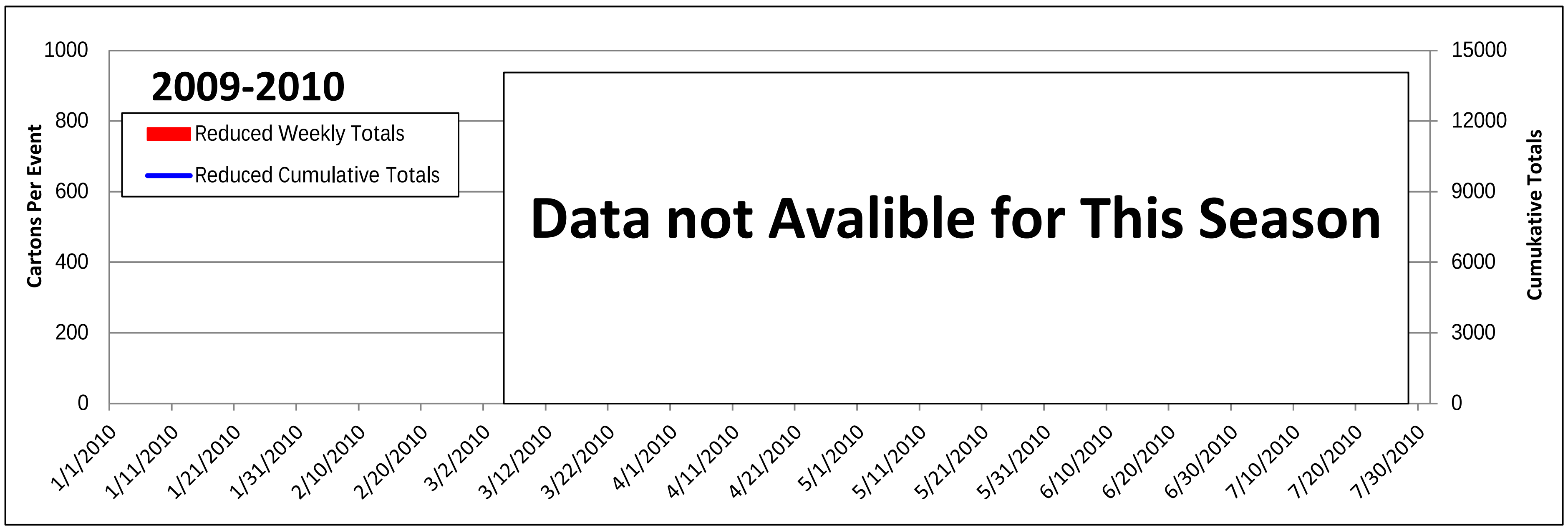


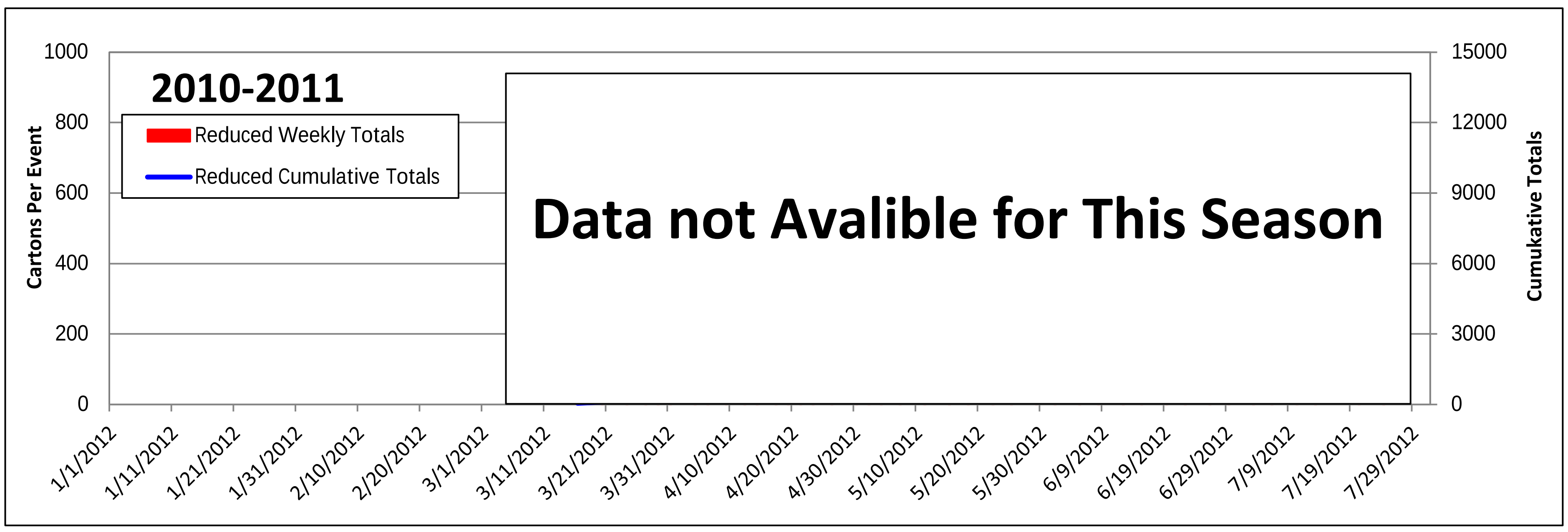


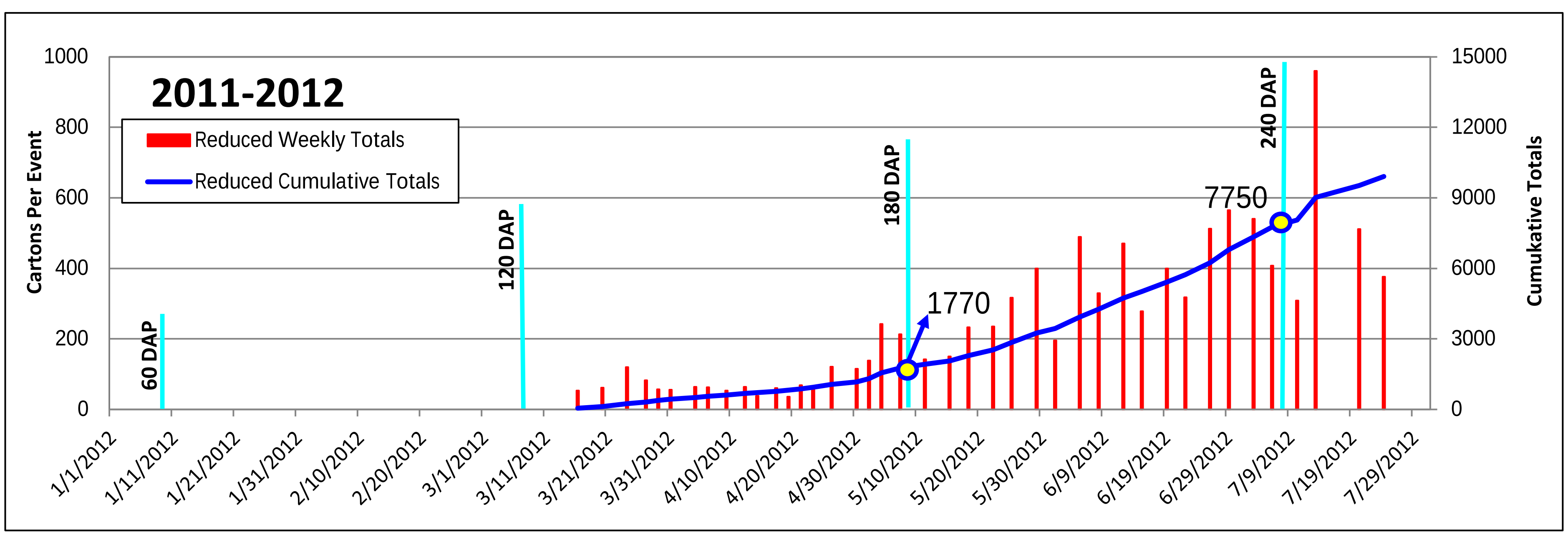


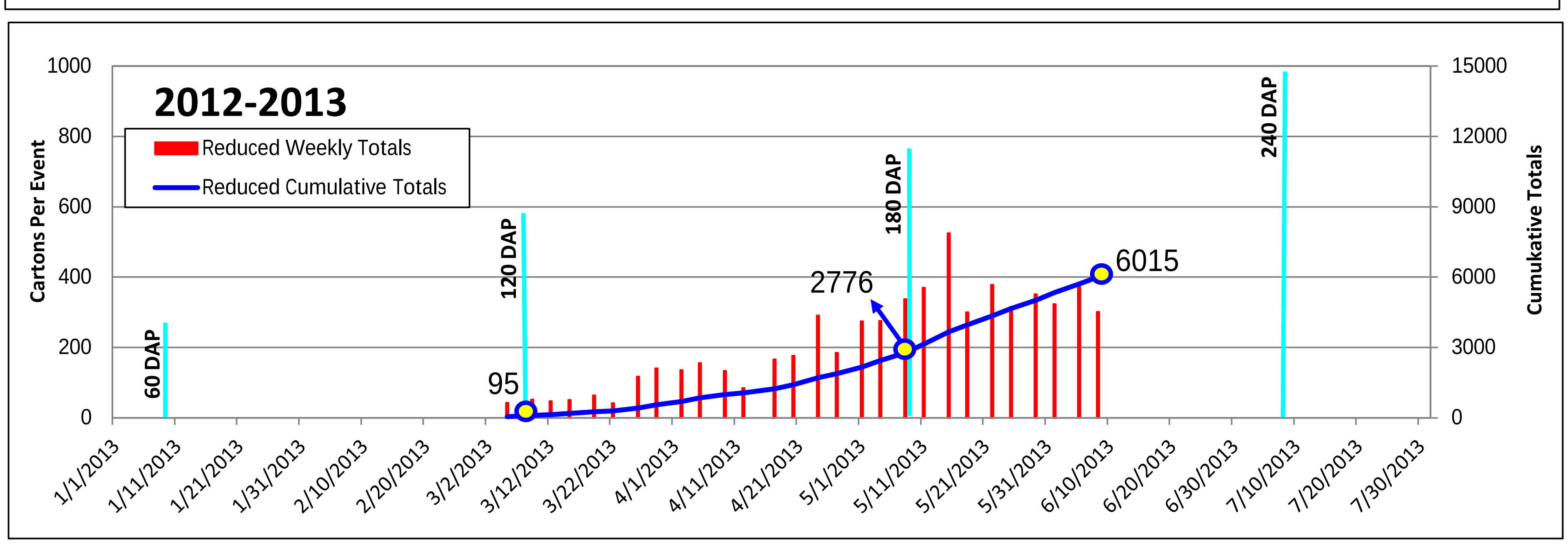


Manzanita Yield Data Comparison - Reduced Sprinkler, 4 Tape

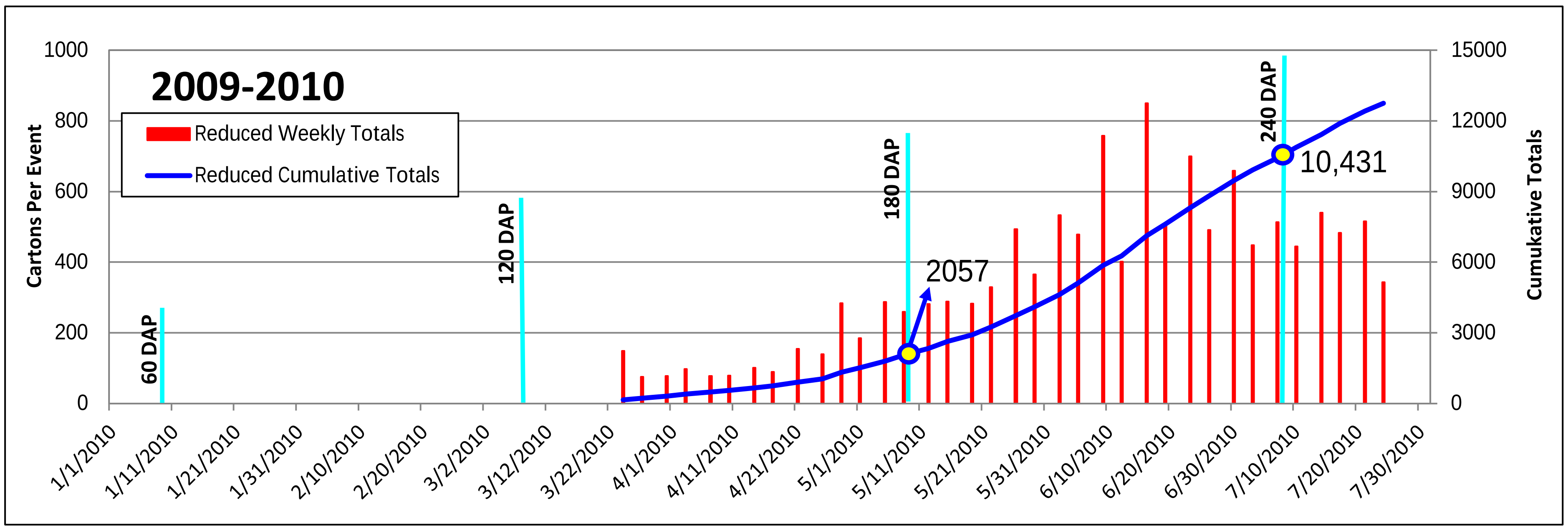


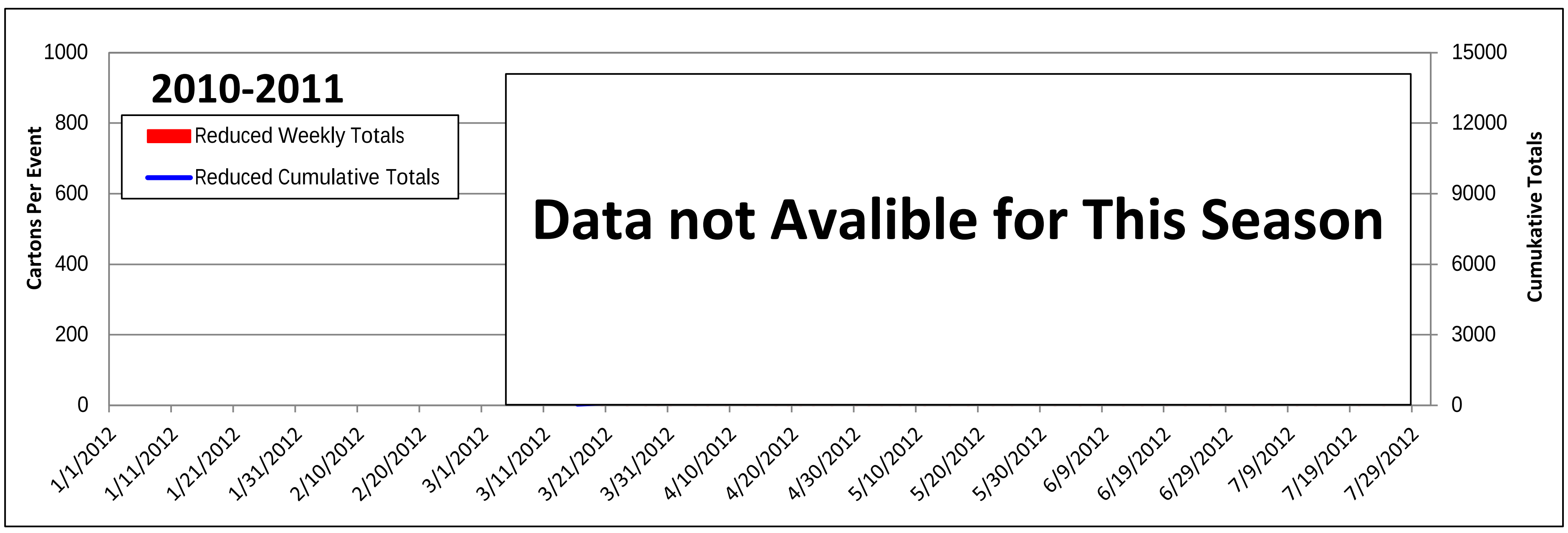


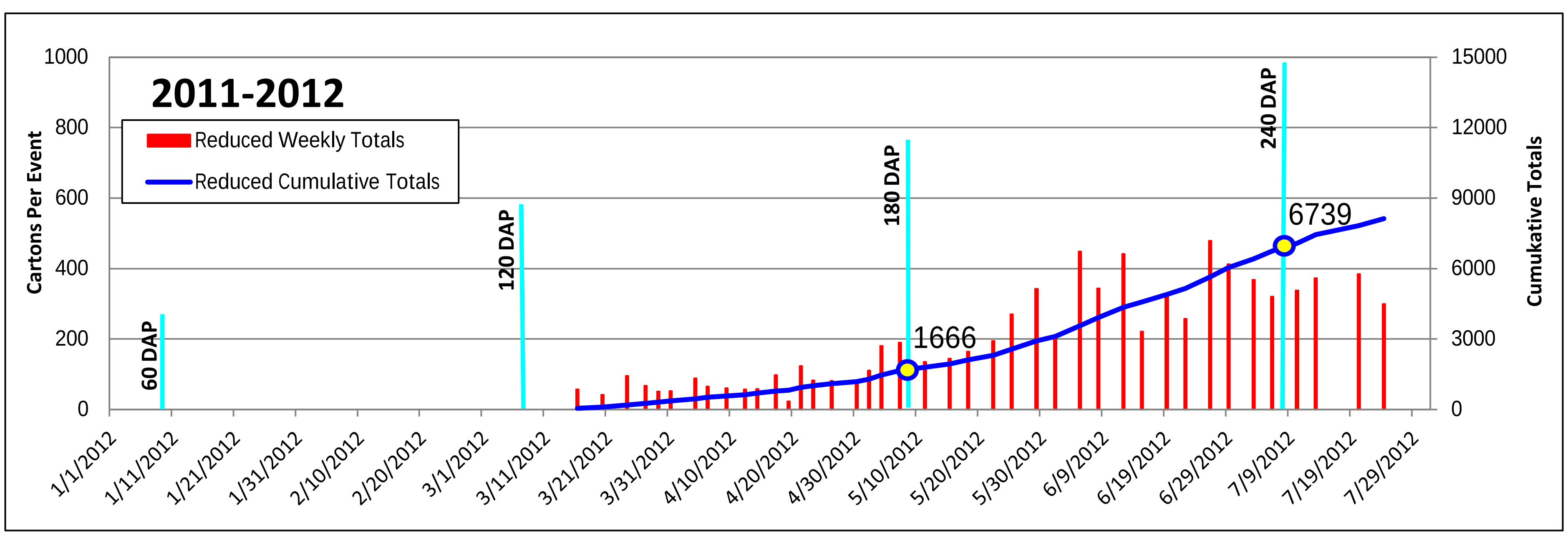


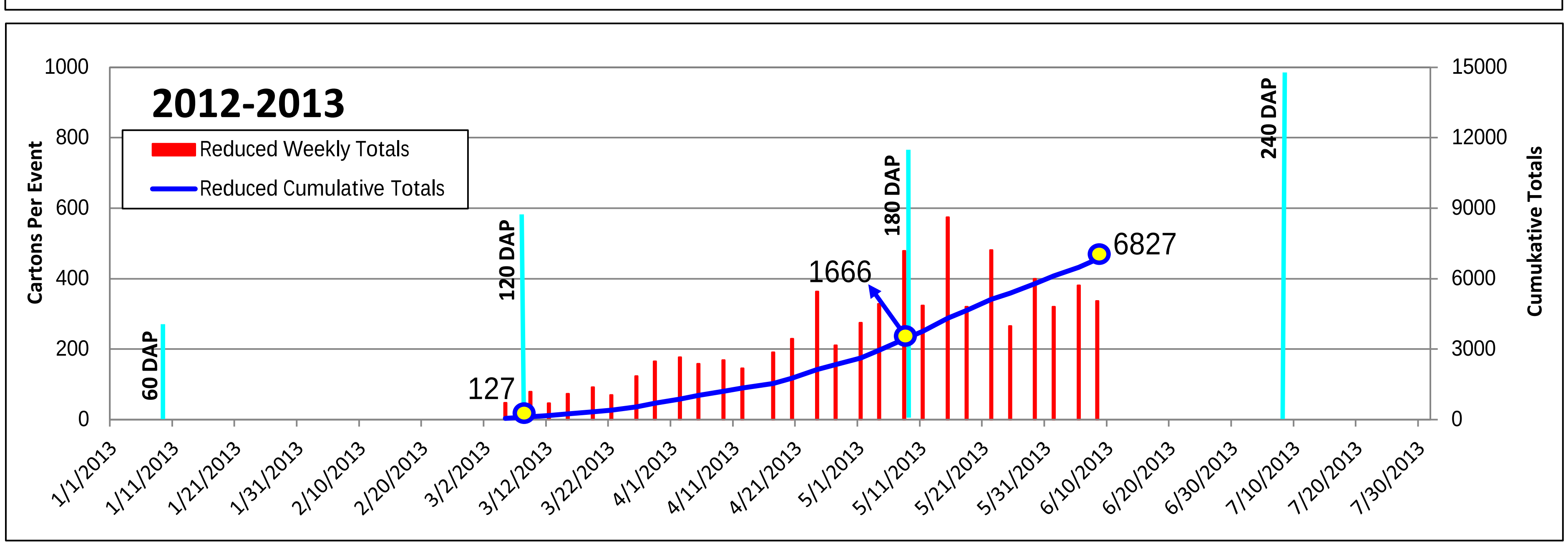


Manzanita Yield Data Comparison - Reduced Sprinkler, 2 Tape







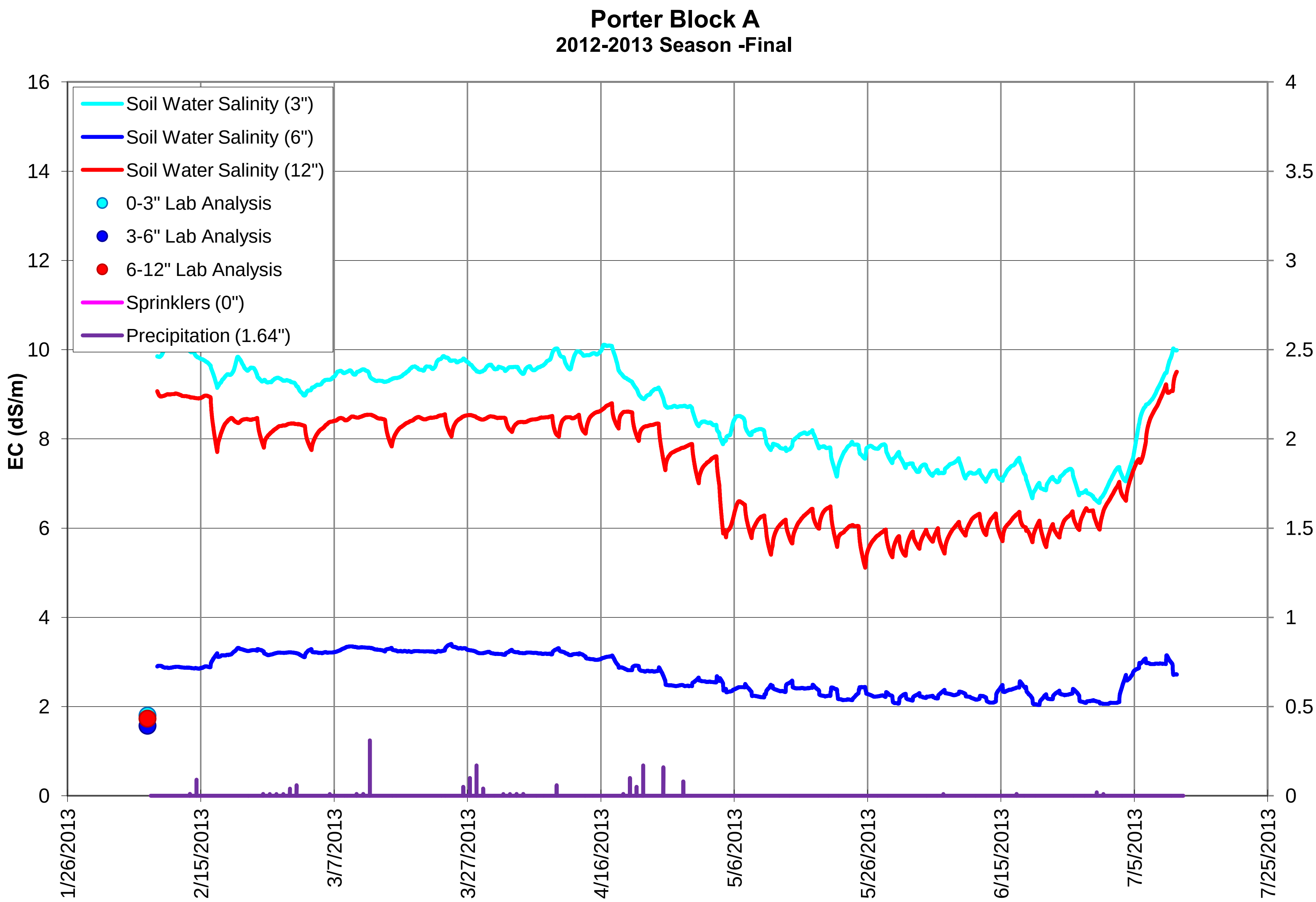


Watsonville

Blocks

2012-2013

Porter



Porter Block A
2012-2013 Season -Final
EC (dS/m)
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (1.64")
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/26/2013
2/15/2013
3/7/2013
3/27/2013
4/16/2013
5/6/2013
5/26/2013
6/15/2013
7/5/2013
7/25/2013

Porter – Block A

1/17/2013


2/7/2013


7/11/2013

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Porter Blocks

Date:		2/7/2013									
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	1.80	58.10								
	3-6"	1.57	61.25								
	6-12"	1.73	48.65								

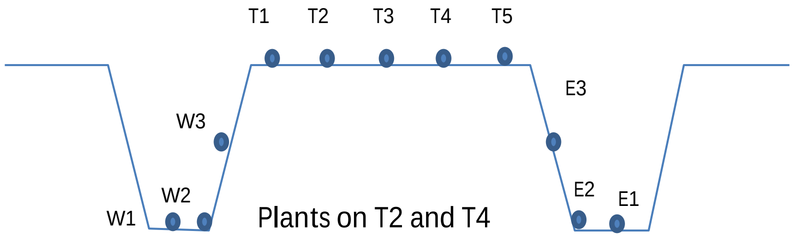
Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler

Salinity Data - Top 3 inches

Porter Ranch (Uyematsuo)

Using 5TE Sensor and ProCheck

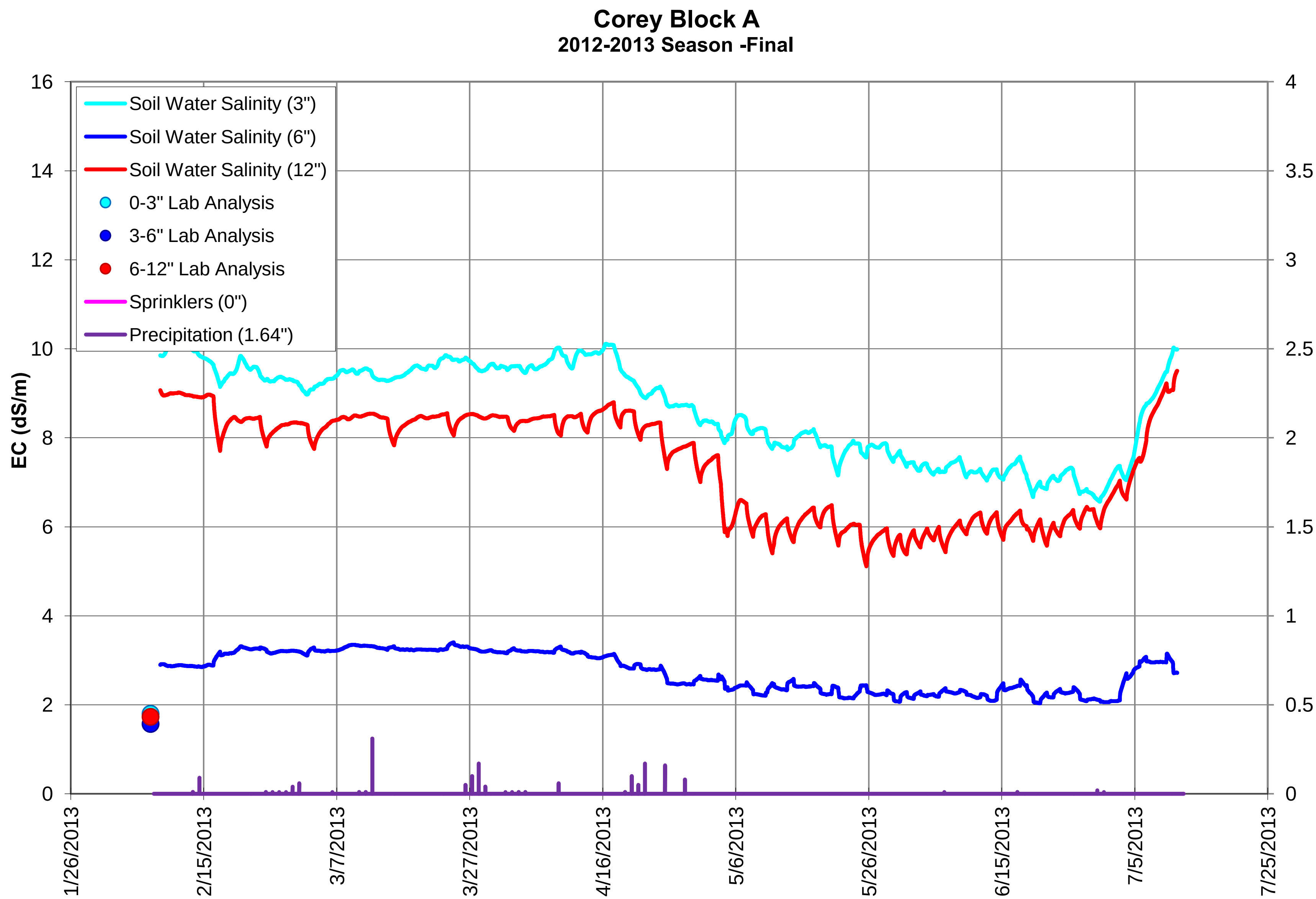
Salinity +8



Porter Ranch (7-Feb-13) - 9:30am

Porter Ranch	West							East		
	W1	W2	W3	T1	T2	T3	T4	T5	E1	E2	E3
Salinity (dS/m)	2.8	3.9	6.4	5.7	3.9	7.8	4.9	5.7	1.6	4.6	2.8
Temp (F)	54	54	54	54	53	53	53	53	56	55	54
% Moisture	21	17	21	22	23	23	25	25	22	16	26

Corey


Corey Block A
2012-2013 Season -Final
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
0-3" Lab Analysis
3-6" Lab Analysis
6-12" Lab Analysis
Sprinklers (0")
Precipitation (1.64")
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/26/2013
2/15/2013
3/7/2013
3/27/2013
4/16/2013
5/6/2013
5/26/2013
6/15/2013
7/5/2013
7/25/2013

Corey – Block A


2/7/2013

7/12/2013

Evaluation of Modified Drip Irrigation Strategies on Strawberries - Corey Block

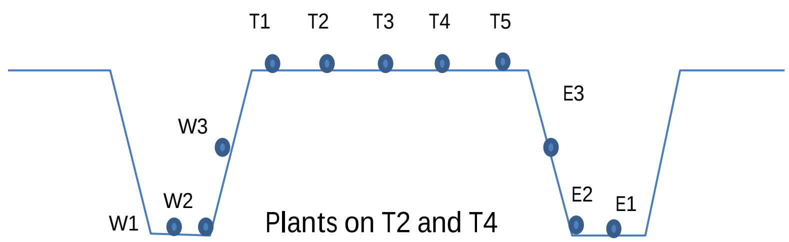
Date:		2/7/2013									
		ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)	ECe Salinity (ds/m)	Chloride (ppm)
Block A	0-3"	2.13	51.80								
	3-6"	4.13	23.80								
	6-12"	2.63	25.20								

Irrigation Methods: SSS = Solid Set Sprinklers, DP = Drip, DLS = Reduced Sprinkler

Salinity Data - Top 3 inches
Corey (RAC)

Using 5TE Sensor and ProCheck

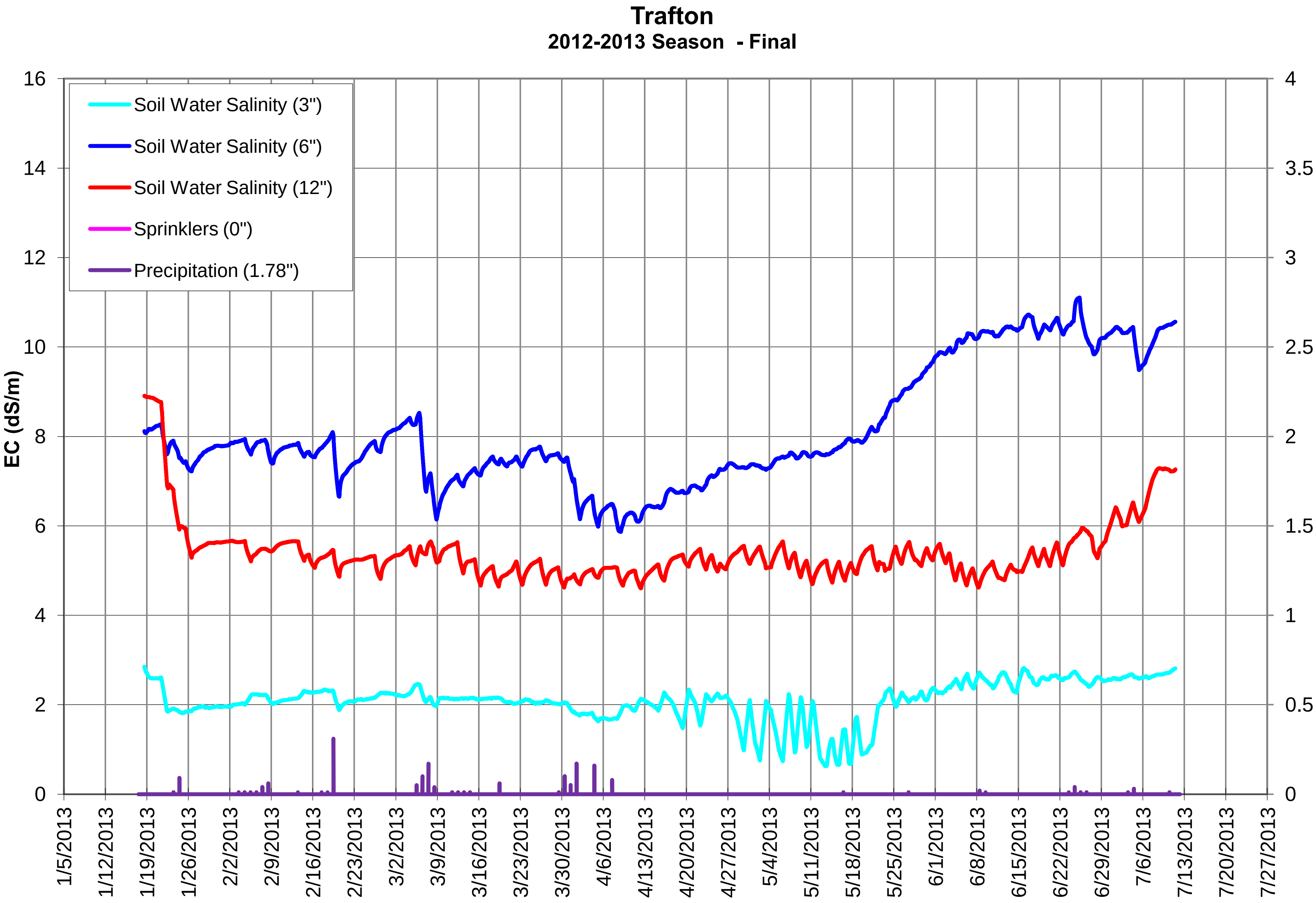
Salinity +8



Corey (7-Feb-13) - 11:45am

Anderson	West							East		
	W1	W2	W3	T1	T2	T3	T4	T5	E1	E2	E3
Salinity (dS/m)	2.2	3.4	8.1	7.7	6.4	6.1	5.4	2.2	2.6	2.4	12.5
Temp (F)	64	64	63	62	61	61	60	60	59	59	60
% Moisture	24	22	23	23	20	25	29	21	24	23	21

Trafton



Trafton
2012-2013 Season - Final
EC (dS/m)
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Soil Water Salinity (3")
Soil Water Salinity (6")
Soil Water Salinity (12")
Sprinklers (0")
Precipitation (1.78")
1/5/2013
1/12/2013
1/19/2013
1/26/2013
2/2/2013
2/9/2013
2/16/2013
2/23/2013
3/2/2013
3/9/2013
3/16/2013
3/23/2013
3/30/2013
4/6/2013
4/13/2013
4/20/2013
4/27/2013
5/4/2013
5/11/2013
5/18/2013
5/25/2013
6/1/2013
6/8/2013
6/15/2013
6/22/2013
6/29/2013
7/6/2013
7/13/2013
7/20/2013
7/27/2013

Trafton – Block A

1/17/2013

2/7/2013

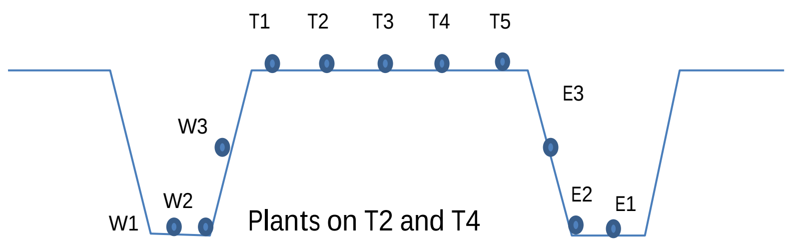
7/11/2013

Salinity Data - Top 3 inches

Trafton (Uyematsuo)

Using 5TE Sensor and ProCheck

Salinity +8



Trafton (7-Feb-13) - 8:30am

Trafton	West								East		
	W1	W2	W3	T1	T2	T3	T4	T5	E1	E2	E3
Salinity (dS/m)	1.9	8.8	11.2	6.0	2.9	6.6	5.3	2.6	11.0	1.2	6.5
Temp (F)	49	49	48	48	48	47	47	47	48	48	47
% Moisture	20	26	20	18	19	19	21	18	25	25	21