

UNIVERSITY of CALIFORNIA COOPERATIVE EXTENSION

The Effect of SURROUND® on Water Relations, Yield and Nut Quality

2010 ANNUAL STATEWIDE PISTACHIO DAY
January 13, 2010 Visalia, CA

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Kern County, California

More than $\frac{1}{4}$ million acres along the Westside of the San Joaquin Valley are affected by poor drainage, perched water and salinity.



Canal water has become 10 times more expensive and much less available compared to 20 years ago.





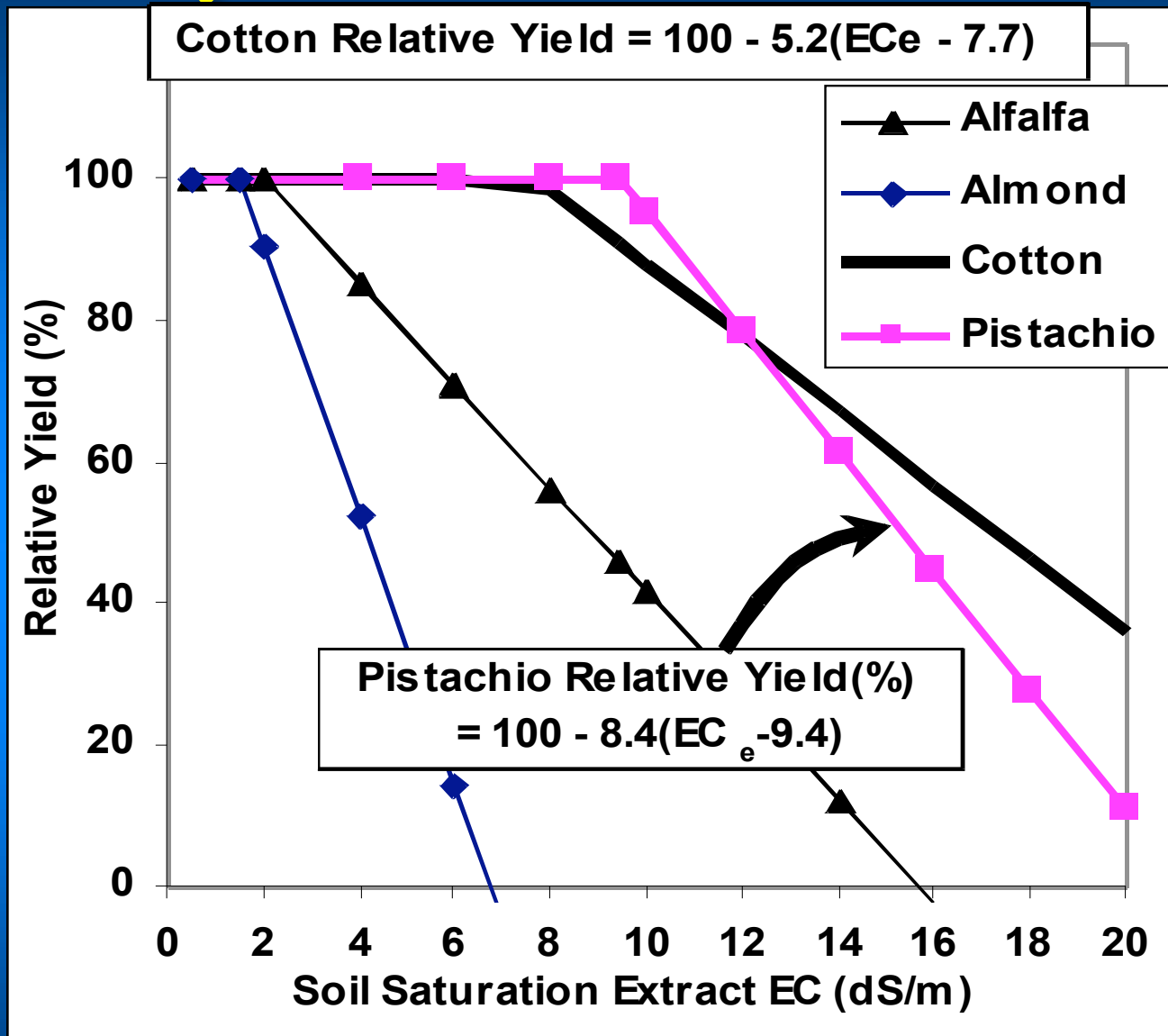
1994 – 2002 Pistachio Salt Tolerance Trial

Precipitated salts on soil surface in
12 dS/m plot (10/13/00)

SALINITY TRIAL IRR. WATER @ 8 dS/m

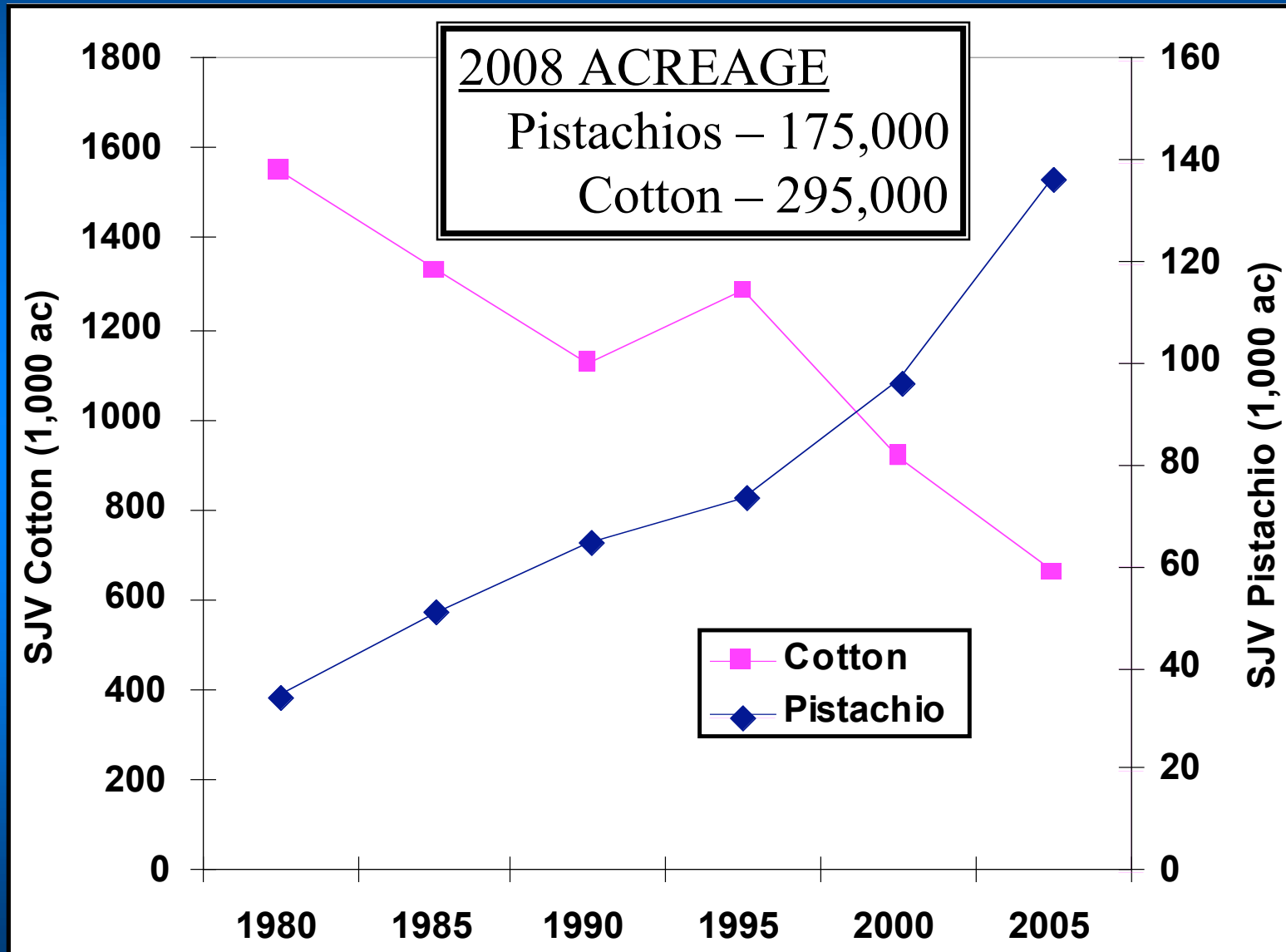
Na: 60 meq/l Cl: 40 meq/l B: 1 ppm
1,380 ppm 1,400 ppm

Relative yield of as a function of soil ECe



Sanden, B.L., L. Ferguson, H.C. Reyes, and S.C. Grattan. 2004. Effect of salinity on evapotranspiration and yield of San Joaquin Valley pistachios. Proceedings of the IVth International Symposium on Irrigation of Horticultural Crops, Acta Horticulturae 664:583-589.

Changes in cotton and pistachio acreage from 1980 to 2005

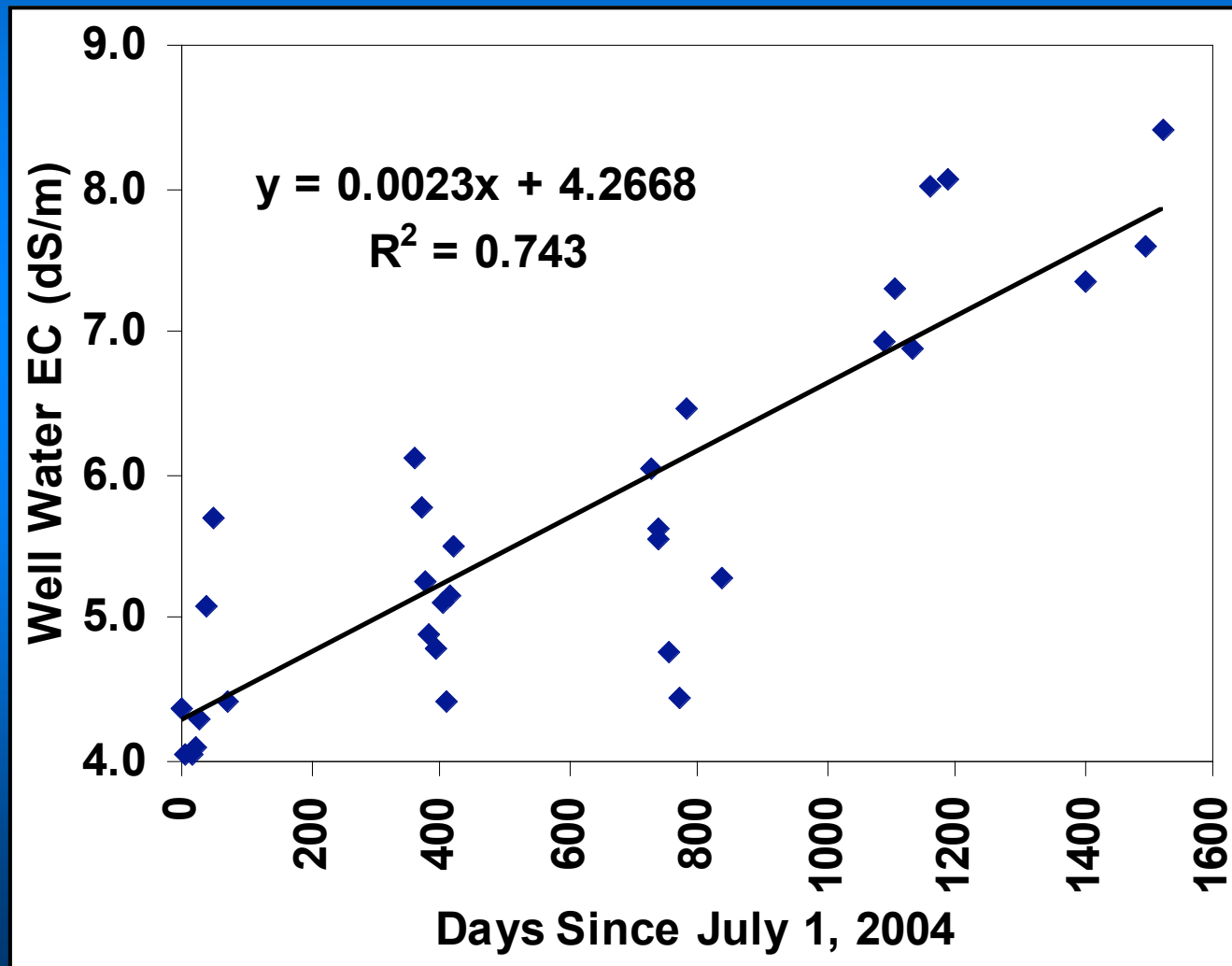


MANY WESTSIDE ORCHARDS ARE MAKING UP SUPPLY DEFICITS WITH WELL WATER.

Average Treatment Water Quality for Starrh Salinity Trial 2004-2009 & Surround Trial 2009

WATER SOURCE	pH	EC	SAR	Ca (meq/l)	Mg (meq/l)	Na (meq/l)	Cl (meq/l)	B (ppm)	HCO3 (meq/l)	CO3 (meq/l)	SO4 (meq/l)	NO3-N (ppm)
Aqueduct	8.0	0.50	2.5	1.2	1.0	2.6	2.2	0.3	1.3	<0.1	0.7	0.5
Blend	7.6	3.42	4.2	14.1	7.8	13.8	20.9	6.5	1.4	<0.1	9.9	2.5
Well	7.6	5.02	5.2	22.2	12.2	21.4	32.3	10.3	1.5	<0.1	19.6	6.6
SURROUND TRIAL WATER QUALITY 9/15/09												
Aqueduct	7.6	0.67	2.8	1.4	1.5	3.3	3.0	0.2	1.7	<0.1		
Well #1	7.8	3.42	8.8	10.2	1.3	21.1	17.8	6.2	1.3	<0.1		
Well #2	7.8	3.54	7.7	12.6	1.8	20.7	16.8	6.7	1.6	<0.1		

Problem: Well water salinity is increasing by 0.84 dS/m/yr



Maybe a protective film that doesn't clog the stomata but reflects some short-wave energy and heat can reduce tree ET without reducing yield.



Surround[®] WP

Crop Protectant

Surround WP crop protectant forms a barrier film, which acts as a broad spectrum agricultural crop protectant for controlling damage from various insect and disease pests, a growth enhancer, and as a protectant against sunburn and heat stress.

ACTIVE INGREDIENT:

Kaolin 95.0%

OTHER INGREDIENTS: 5.0%

TOTAL: 100.0%

CONTAINS NON-PLANT FOOD INGREDIENT:

GUARANTEED ANALYSIS

Active ingredients

95% Kaolin

5% Inert ingredients

**KEEP OUT OF REACH OF CHILDREN
CAUTION/PRECAUTION**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID	
If in eyes:	<ul style="list-style-type: none"> • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-877-1737 for emergency medical treatment information.	

The use of **Surround WP** in agricultural crop protection applications is covered by US Patents 6,027,740; 6,069,112; 6,110,867 and 6,156,327.

EPA Reg. No. 61842-18

**EPA Est. No. 51036-GA-001
EPA Est. No. 72797-AL-001**

Growth enhancer uses are not registered in California.

UNIVERSITY of CALIFORNIA COOPERATIVE EXTENSION

Project Title: Impacts of kaolin spray on pistachio leaves to reduce evapotranspiration, insecticide usage, and energy consumption through water pumping

Co-investigators:

Charles Burt, BioResource and Ag Engineering, Cal Poly SLO

Franklin Gaudi, Cal Poly SLO

Craig Kallsen, Sub-tropical Crops, UCCE Kern County

Cooperator: RTS Agribusiness

Funding: CA Department of Food and Agriculture, CSU Ag Research Initiative, NovaSource (in-kind)

SURROUND / IRRIGATION TRIAL

OBJECTIVES:

IMPACT ON CROP WATER USE

Reduce crop water use, and therefore pumping energy requirements, without impacting yield.

IMPACT ON CROP STRESS

Reduce crop stress due to greater reflectance of short wave energy. Thus...

IMPACT ON CROP QUALITY

Maintain or improve split percentage. Reduce or eliminate navel orange worm damage and/or need for NOW sprays.

TREATMENT: Surround 5/21/09 @ 75 lb/ac, 150 gals, 2.5 mph
Surround 6/10/09 @ 75 lb/ac, 150 gals, 2.5 mph, 16 oz Silgard

METHODOLOGY:

 SATELITE EVALUATION OF NDVI / ET

Apply treatments to 32 row x ½ mile plots allowing for estimate of Normalized Differential Vegetative Index (NDVI) and SEBAL® crop evapotranspiration (ET)

 GROUND-BASED ET AND TREE STRESS

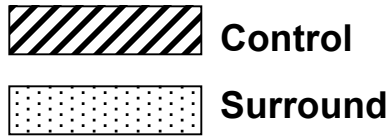
Weekly replicated neutron probe soil water content measurements to a depth of 9 feet, applied water through drip hose and tree stem water potential (SWP)

 LARGE-SCALE / SMALL PLOT YIELD / QUALITY

Separate all loads from each large plot to determine bulk yield/quality. Small plot (6 tree) hand harvest to determine SURROUND yield/quality impacts comparing grower irrigation schedule to 50% deficit irrigation.

June 2008 Aerial Planted 1999-2000 (1 ft resolution)





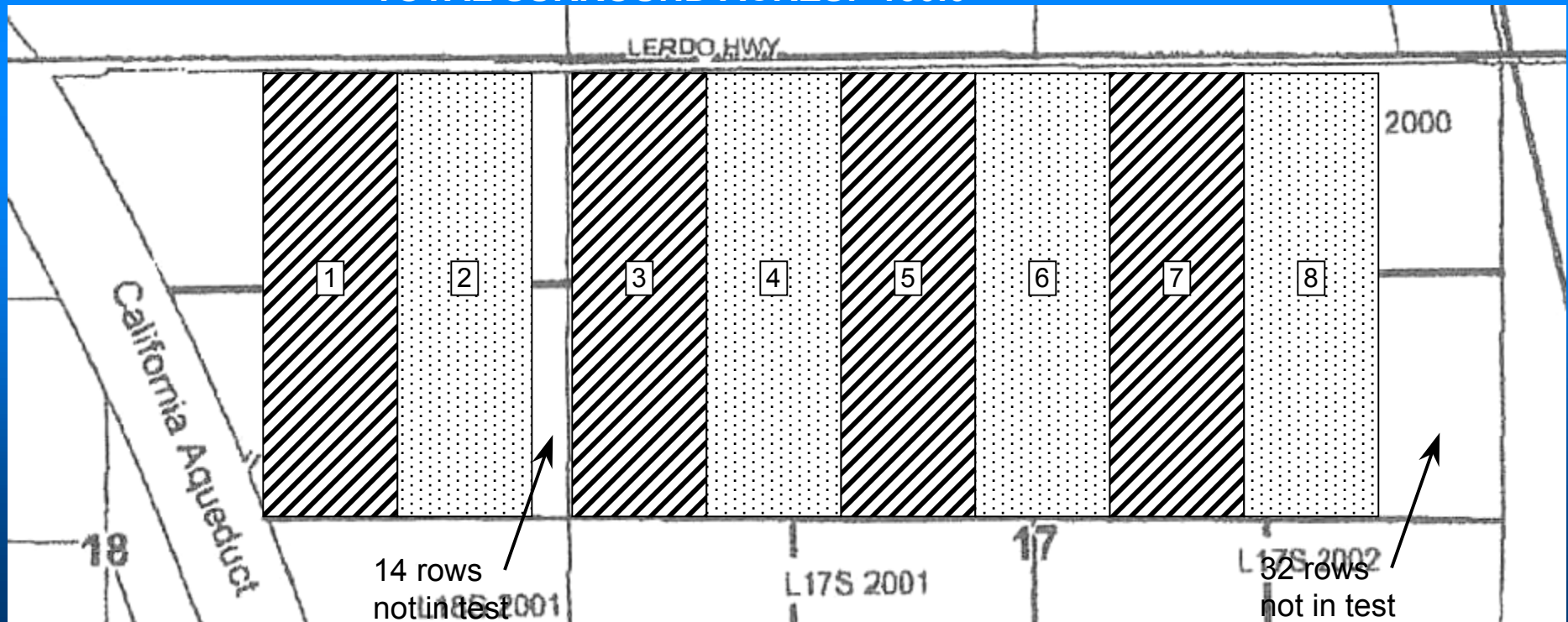
Plots are 32 rows wide by 150 trees long N to S (except for the first 20 rows of Plot 1, west, with 151 trees) with a 51 foot farm road in the middle. Plot numbers also indicate the placement of neutron probe access tubes and in-line flowmeters on hoses (Sited on the N side of the 15th tree S of middle road on the 16th row from W side of plot). WEST EDGE OF PLOT 1 IS FIRST FULL ROW ON SW CORNER AGAINST AQUEDUCT.

TREE SPACING: 17 x 20 feet

TREES/PLOT: 4800

TREE ACRES/PLOT: 37.5 (640 x 2600 ft including middle road)

TOTAL SURROUND ACRES: 150.0



**WHAT DID WE
FIND OUT?**

NO IMPACT

(Are we done?)

IN-SEASON DATA COLLECTION

- Spring and fall soil samples
- Mid-season water sample
- Weekly neutron probe soil moisture monitoring 4/29 to 11/1/09
- Midday stem water potential (SWP, measured using shaded bagged leaf water potential and pressure bomb) 5/6 to 9/13/09



Inspecting trees and
neutron probe sites
with the Expert Nut
of Kern County UC
Extension 5/15/09



Flowmeter
Neutron Probe
tube to 9 feet

Tree spacing 17 x 20 ft
3, 1 gph PC drips/tree
(NP tube 24" from dripper)

Airblast Sprayer w/o tower

1st Application 5/21/09



Reasonable coverage after 1st
application (5/21/09)



1st Application

5/21/09



2nd Application

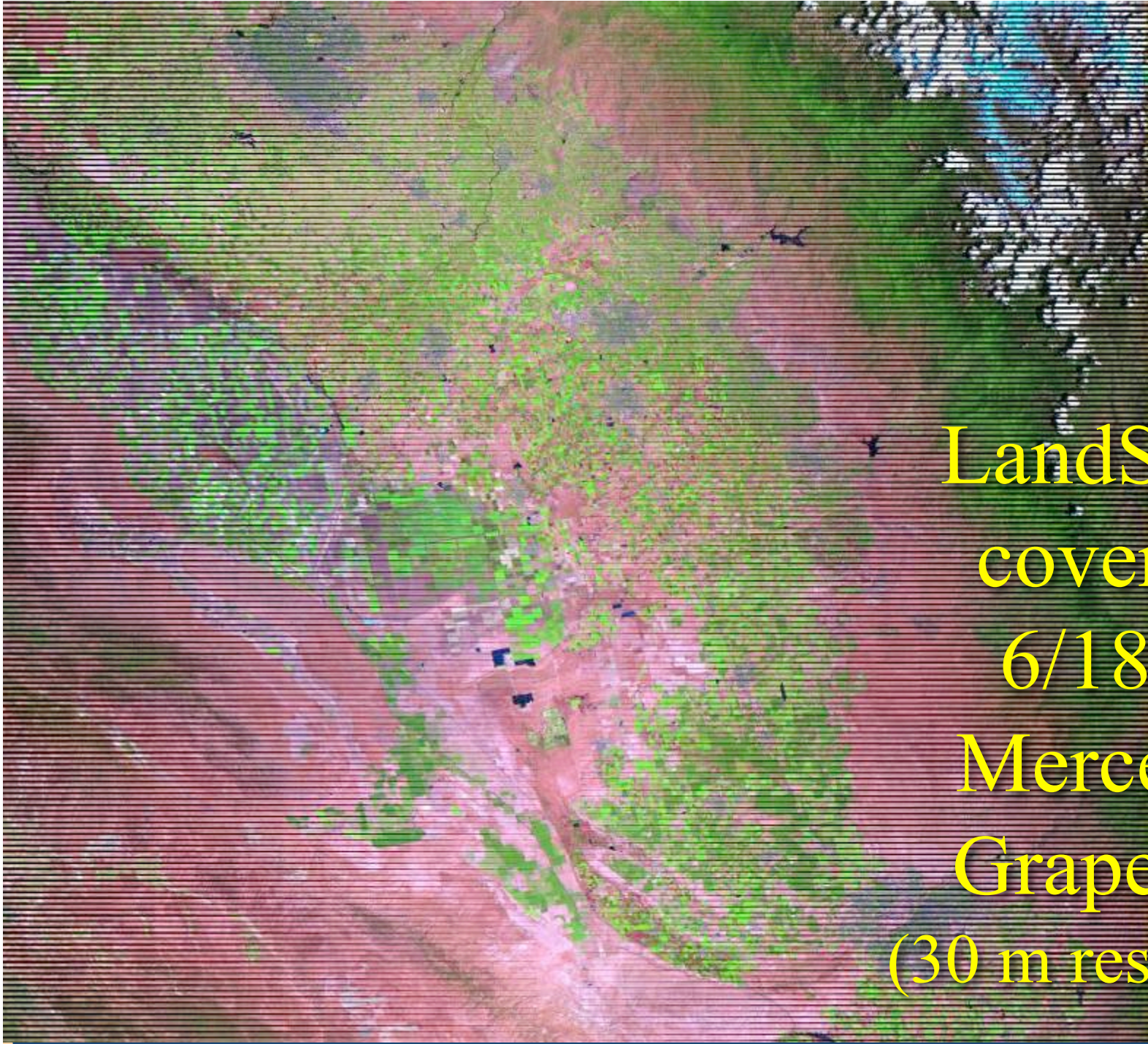
6/10-11/09





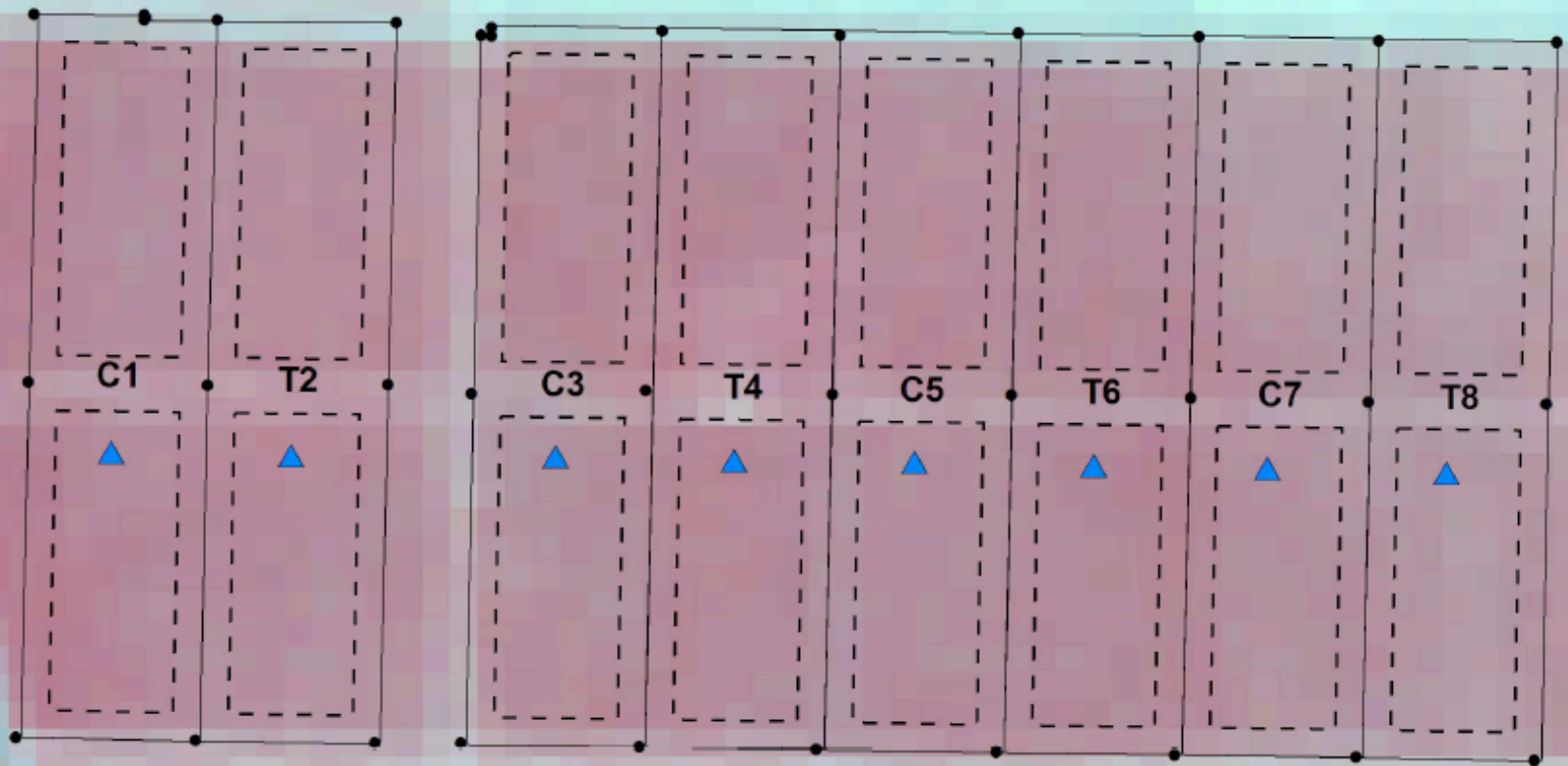
Excellent coverage after 2
applications (6/17/09)

**WHAT DID THE
SATELITE
DATA SHOW?**



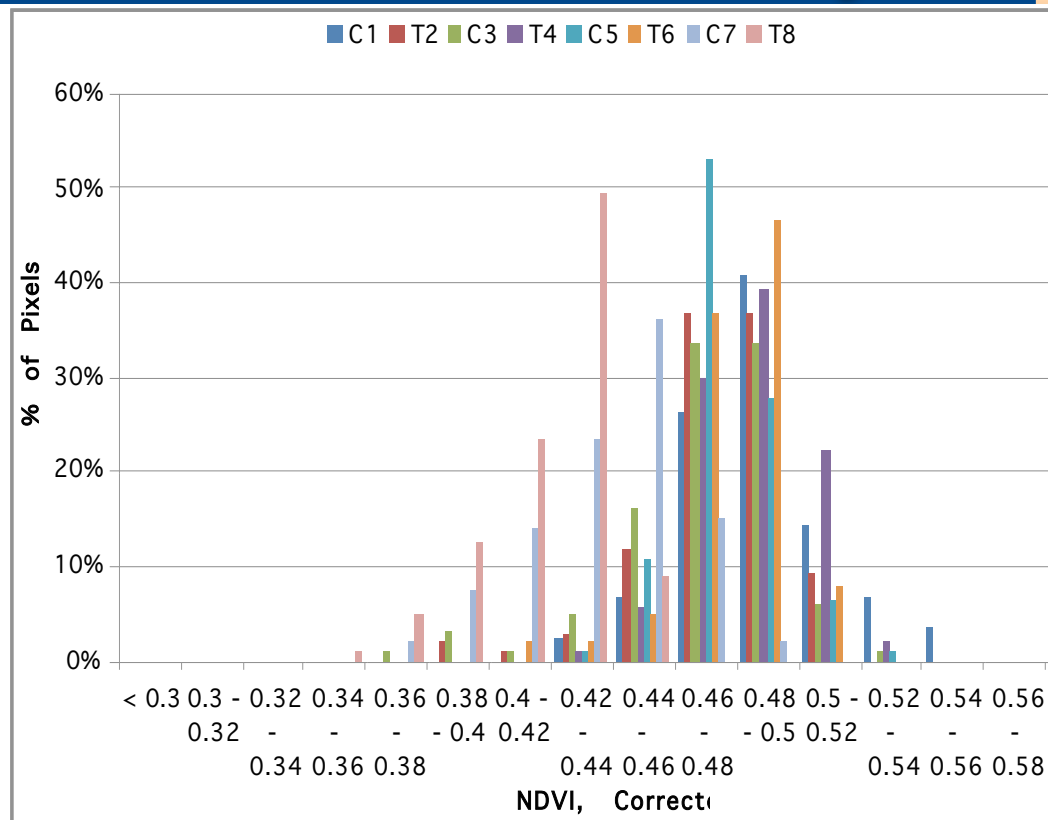
LandSAT7
coverage
6/18/09
Merced to
Grapevine
(30 m resolution)

Remote sensing analysis from Landsat 7 imagery 8/2/2008 (False color composite, 30m (~100ft)/pixel)



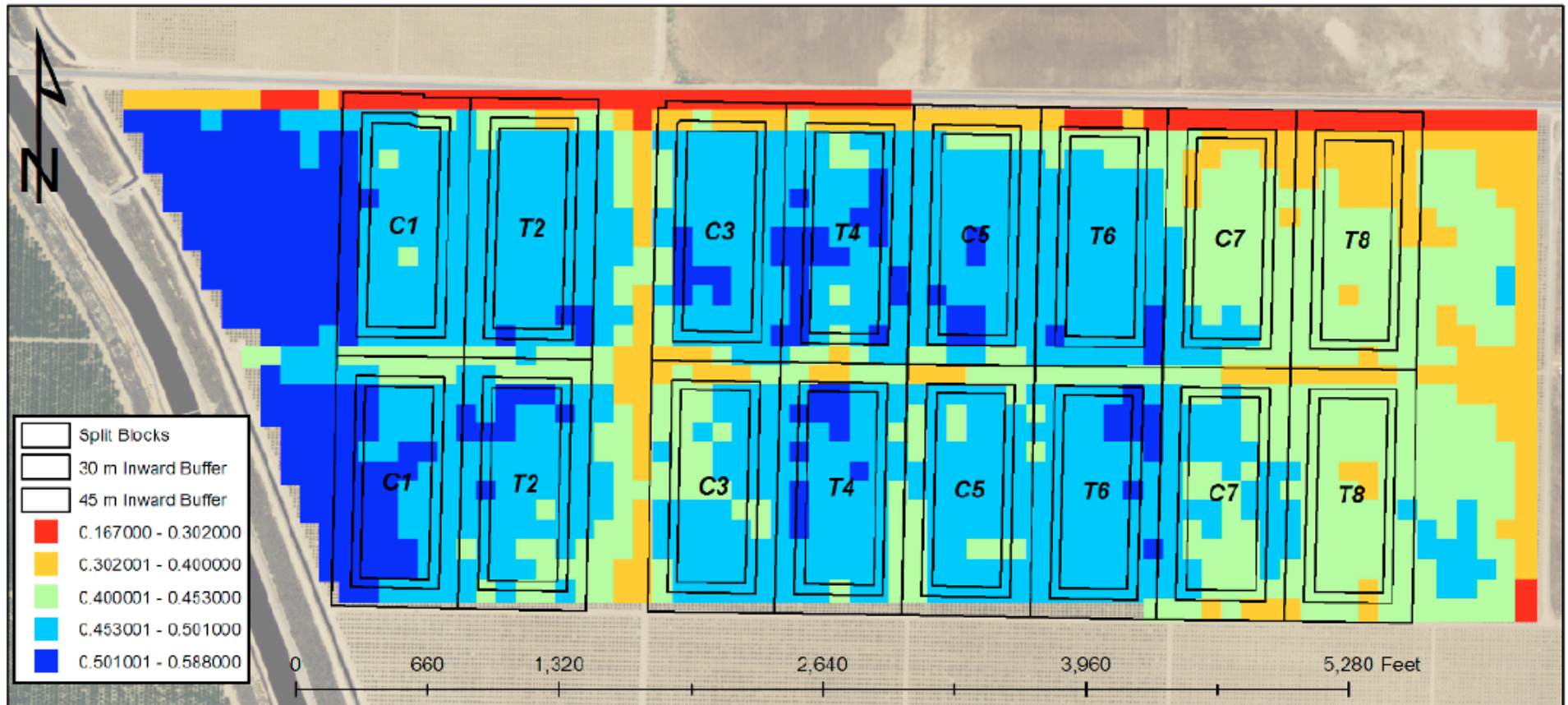
Processing Landsat data for statistical analysis

Parameter	Block	Summary Statistics					
		n	min	max	mean	median	std dev
NDVI, corrected	C1	91	0.430	0.554	0.488	0.486	0.024
	T2	109	0.394	0.514	0.476	0.479	0.022
	C3	99	0.378	0.524	0.471	0.475	0.028
	T4	104	0.440	0.524	0.487	0.490	0.018
	C5	94	0.439	0.521	0.477	0.474	0.017
	T6	103	0.410	0.519	0.478	0.481	0.019
	C7	94	0.369	0.487	0.438	0.445	0.025
	T8	103	0.358	0.451	0.418	0.421	0.020
NDVI, uncorrected	C1	91	0.382	0.487	0.429	0.427	0.021
	T2	109	0.348	0.453	0.419	0.421	0.020
	C3	99	0.332	0.460	0.414	0.417	0.024
	T4	104	0.386	0.460	0.428	0.430	0.016
	C5	94	0.386	0.459	0.419	0.417	0.015
	T6	103	0.361	0.455	0.419	0.422	0.016
	C7	94	0.325	0.427	0.385	0.391	0.021
	T8	103	0.315	0.396	0.368	0.371	0.017
Albedo	C1	91	0.160	0.184	0.167	0.167	0.004
	T2	109	0.166	0.187	0.172	0.172	0.003
	C3	99	0.159	0.190	0.170	0.168	0.005
	T4	104	0.162	0.181	0.168	0.167	0.004
	C5	94	0.164	0.176	0.170	0.170	0.002
	T6	103	0.162	0.183	0.168	0.167	0.003
	C7	94	0.168	0.193	0.176	0.176	0.005
	T8	103	0.172	0.201	0.181	0.180	0.006
Surface Temperature (K)	C1	78	307.53	310.16	309.07	309.31	0.74
	T2	62	308.76	310.95	309.85	309.83	0.53
	C3	75	308.61	310.86	310.02	309.97	0.49
	T4	66	308.34	311.88	309.64	309.38	0.67
	C5	74	308.66	312.03	310.05	309.97	0.77
	T6	66	309.17	312.33	310.23	309.92	0.86
	C7	76	310.02	313.65	311.22	311.08	0.81
	T8	69	311.05	313.69	312.29	312.22	0.65



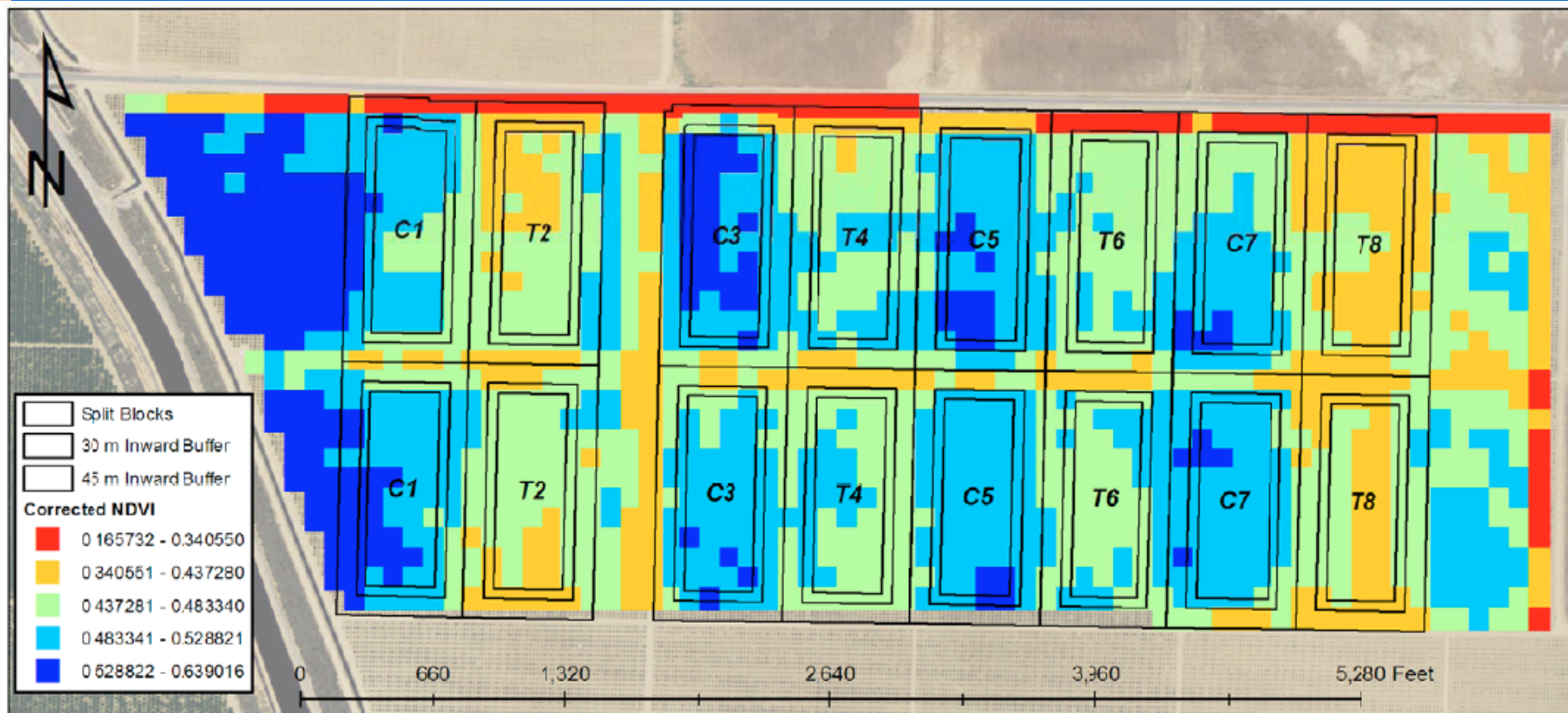
1772 Picasso Avenue, Suite E
 Davis, CA - 95618
 PH: (530) 757 - 9200
 Fax: (530) 757 - 9204
www.sebal.us

Remote sensing analysis from Landsat 7 imagery 8/2/2008 (Color enhanced NDVI (normalized differential vegetative index) 30m buffer)



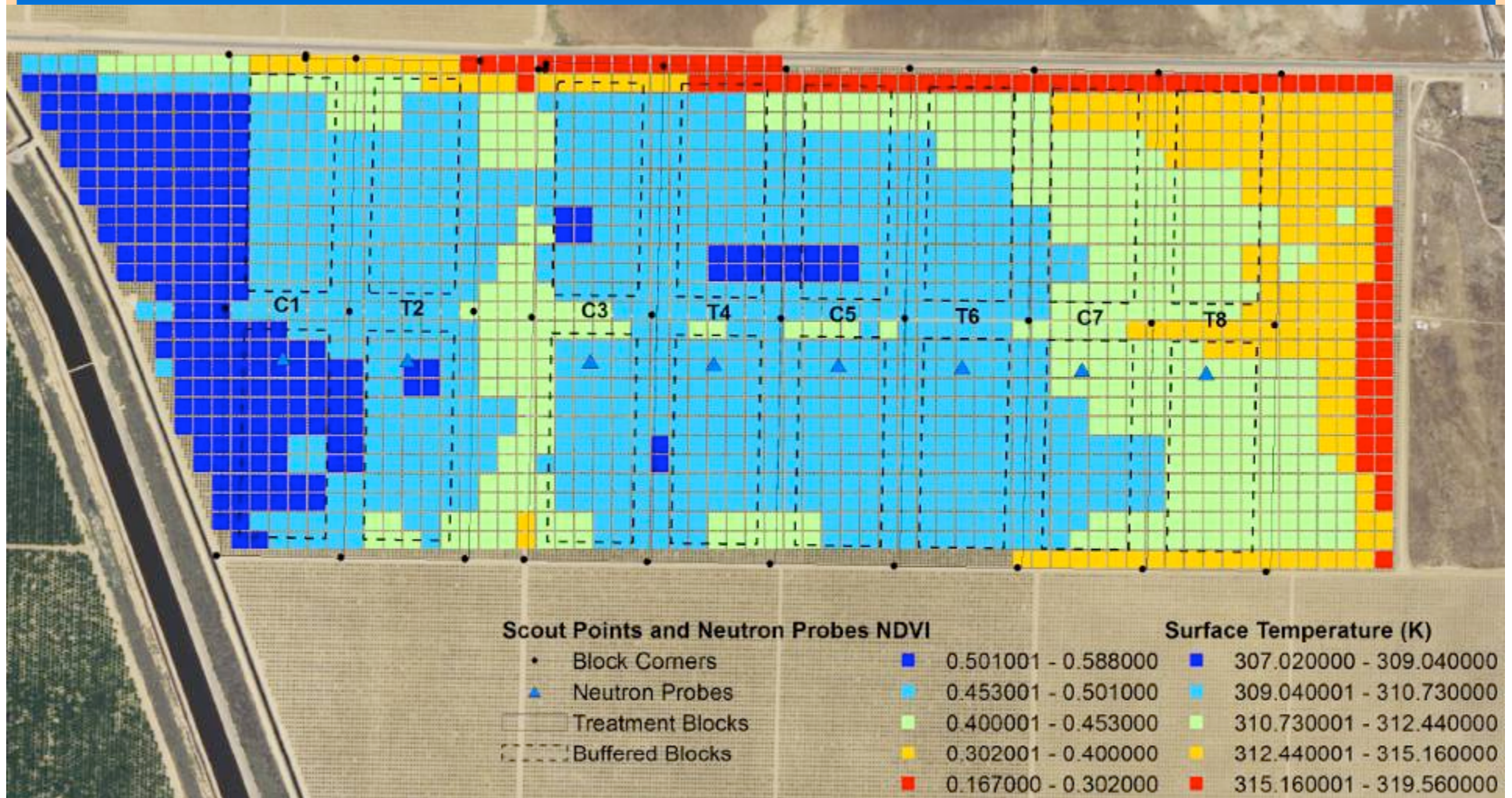
**Corrected NDVI on August 2, 2008 before Application of
Surround[®]**

Remote sensing analysis from Landsat 7 imagery 6/18/09 (Color enhanced NDVI (normalized differential vegetative index) 30m buffer)

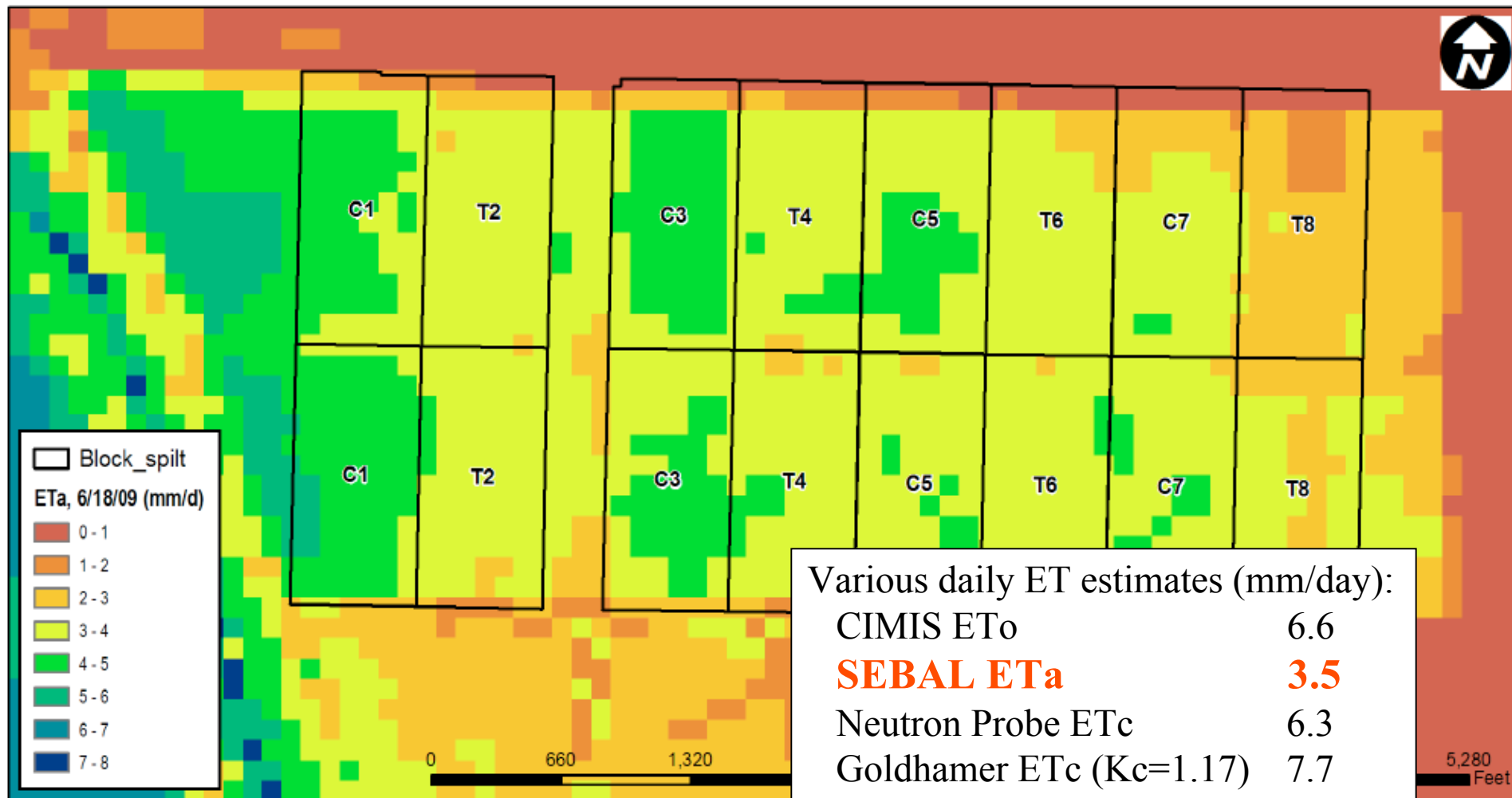


Corrected NDVI on June 18, 2009 after Application of
Surround[®]

SEBAL[®] (Surface Energy Balance Algorithm for Land) estimate of crop ET (LandSAT 8/2/2009) (Color enhanced canopy temperature (45m buffer) added to infrared and near infrared reflectance (30m) to estimate ET)



SEBAL® (Surface Energy Balance Algorithm for Land) estimate of crop ET (LandSAT 6/18/2009) (Color enhanced mm/day 30m pixels, 45m buffer for stats)

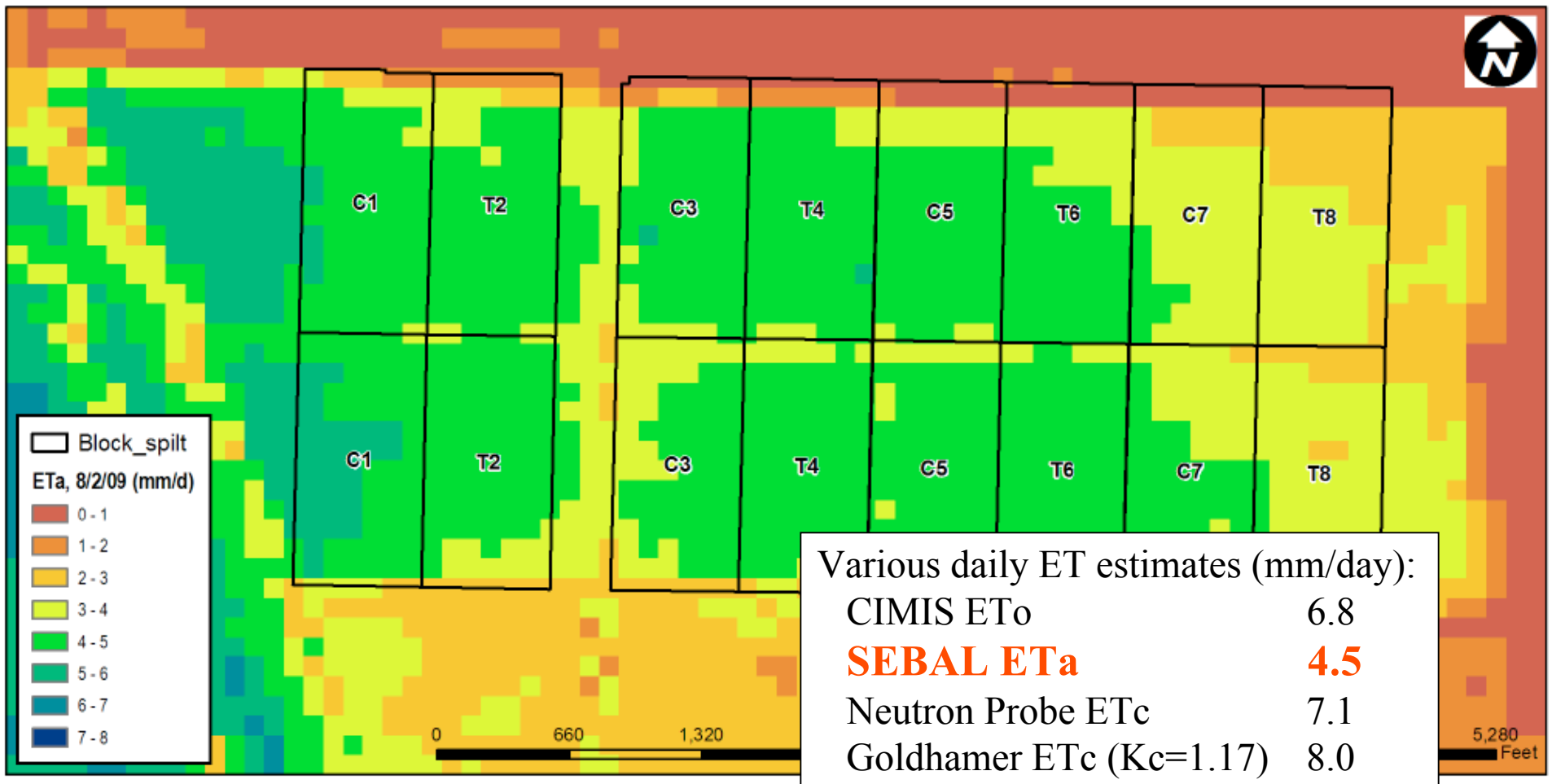


ET_a on June 18, 2009 after Application of Surround®



New green growth expanding
above SURROUND (8/18/09)

SEBAL[®] (Surface Energy Balance Algorithm for Land) estimate of crop ET (LandSAT 8/2/2009) (Color enhanced mm/day 30m pixels, 45m buffer for stats)



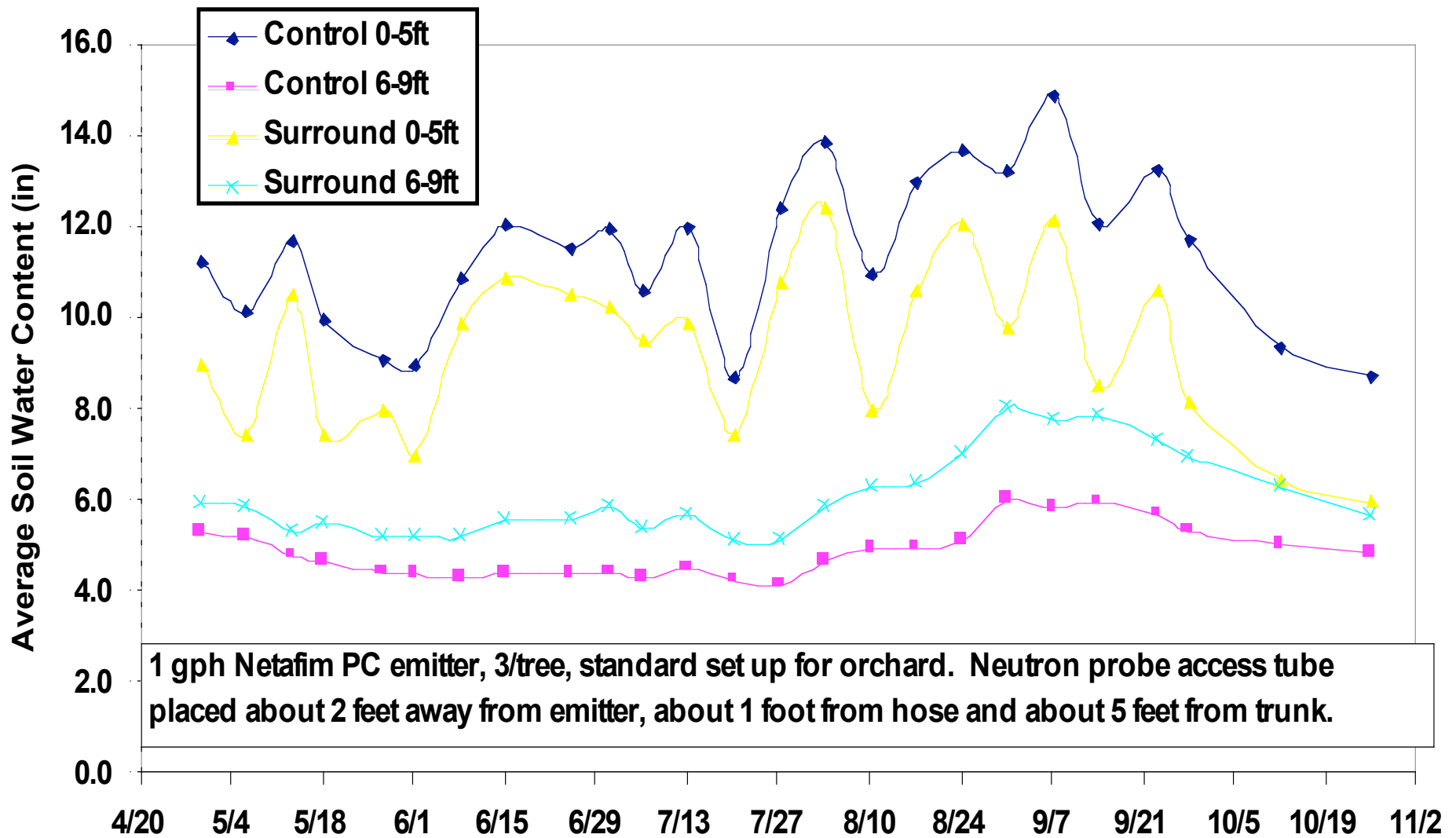
ET_a on August 2, 2008 before Application of Surround[®]

SATELITE DATA CONCLUSIONS:

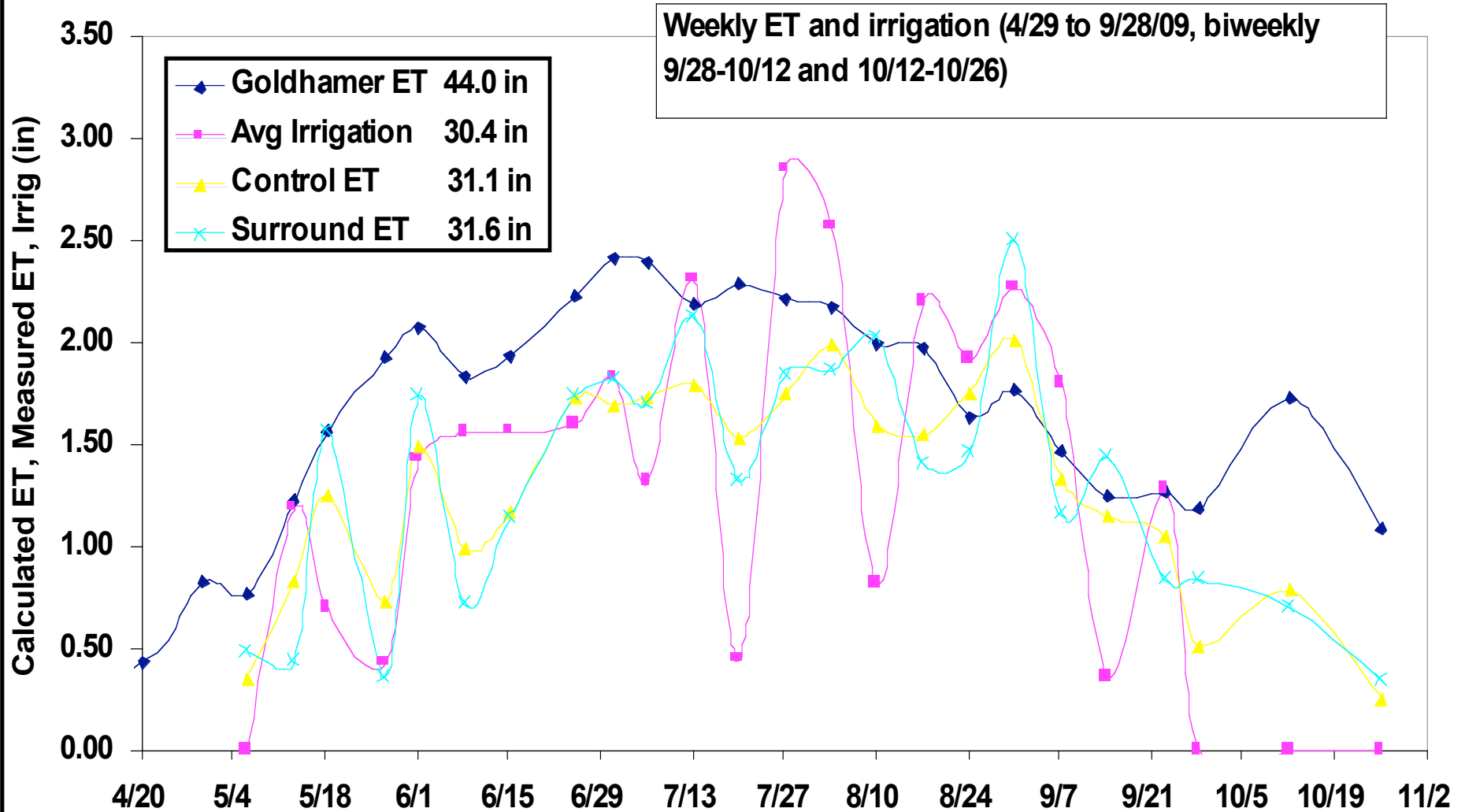
- **High degree of reflectance due to white kaolin interferes with current processing formulas for NDVI and ET.**
- **No impact of SURROUND treatment based on these techniques.**

**WHAT DID THE
GROUND-BASED
DATA SHOW?**

Weekly total water content for 0-5 and 6-9 foot depths



Comparison of various weekly ET calculations and irrigation



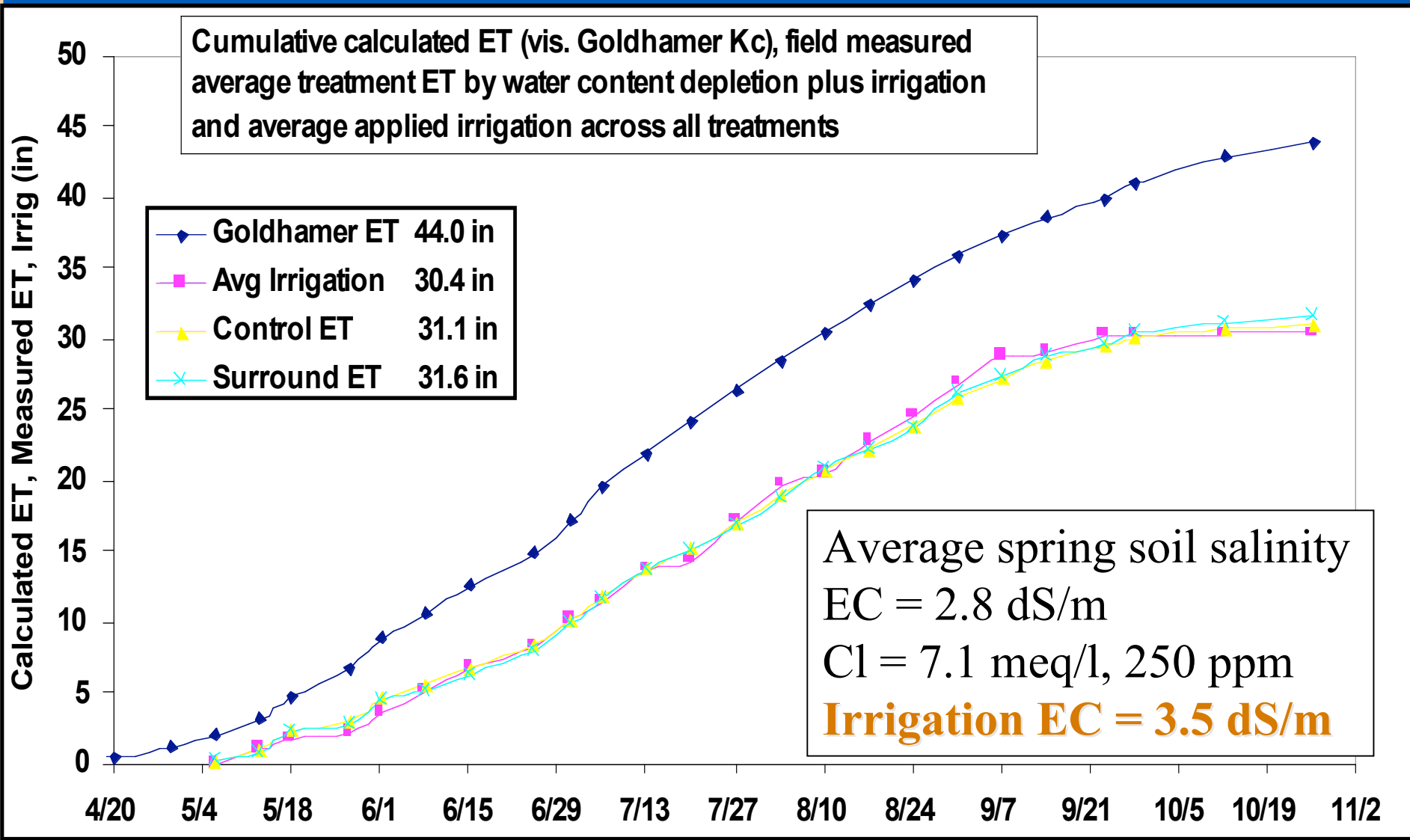
Significant chloride burn
was evident by August...



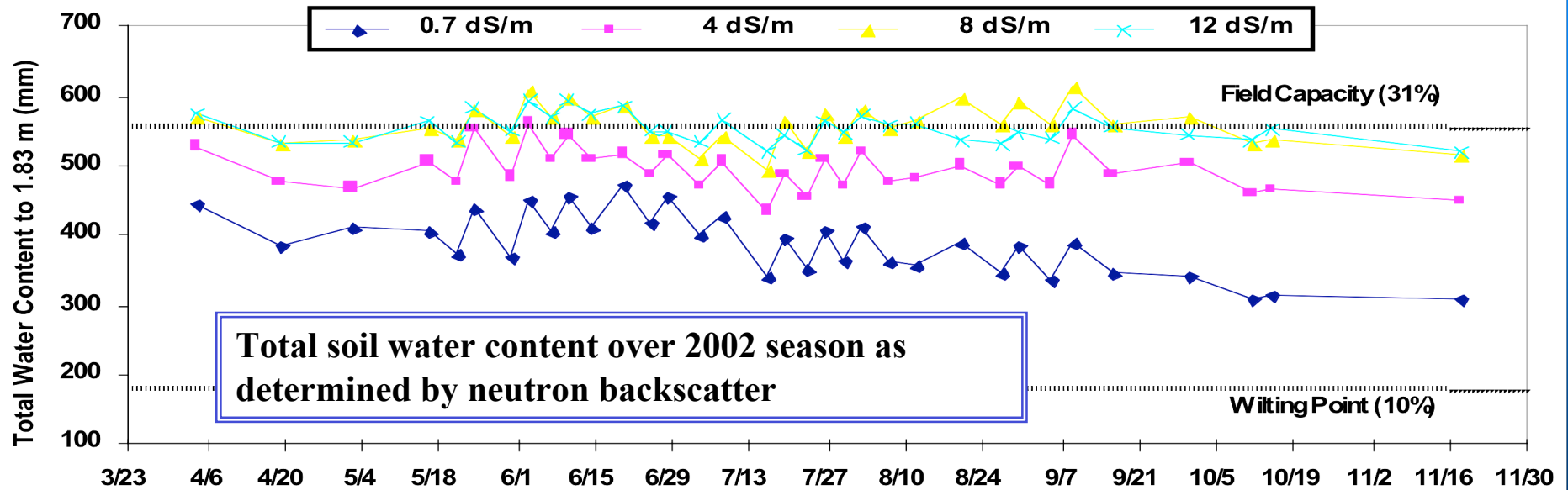
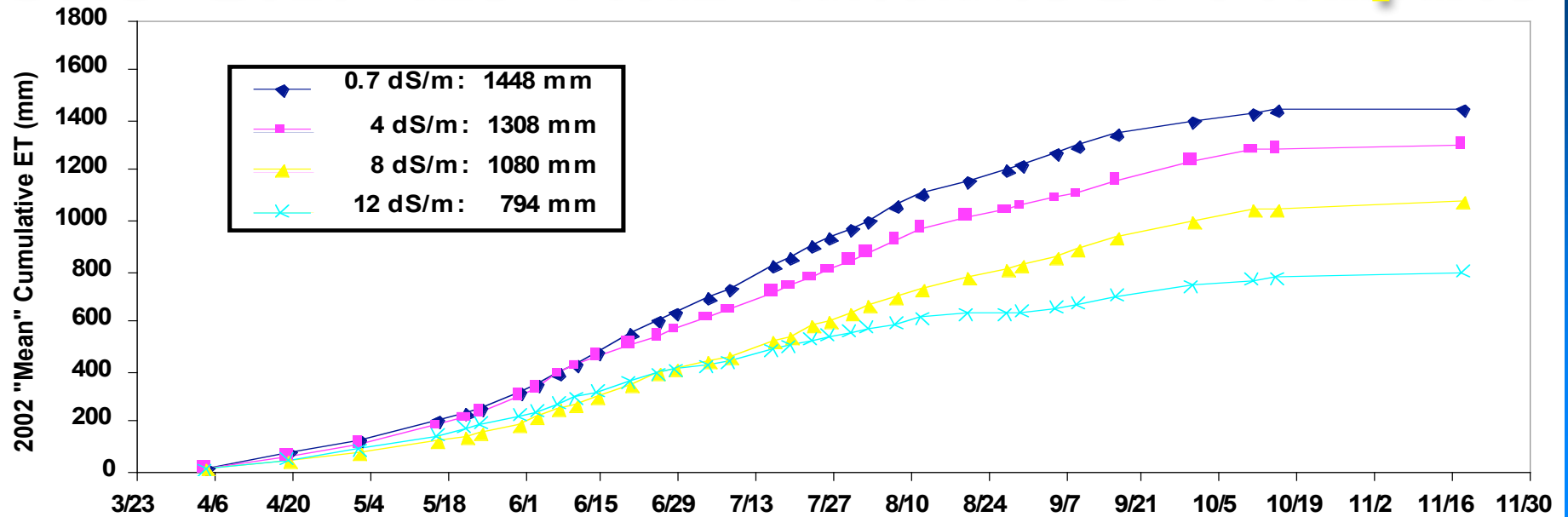
...and was seen as marginal burn on almost all leaves by harvest (9/14/09). Visual ratings estimated 6 to 20% of the leaf area burned by 10/1/09.



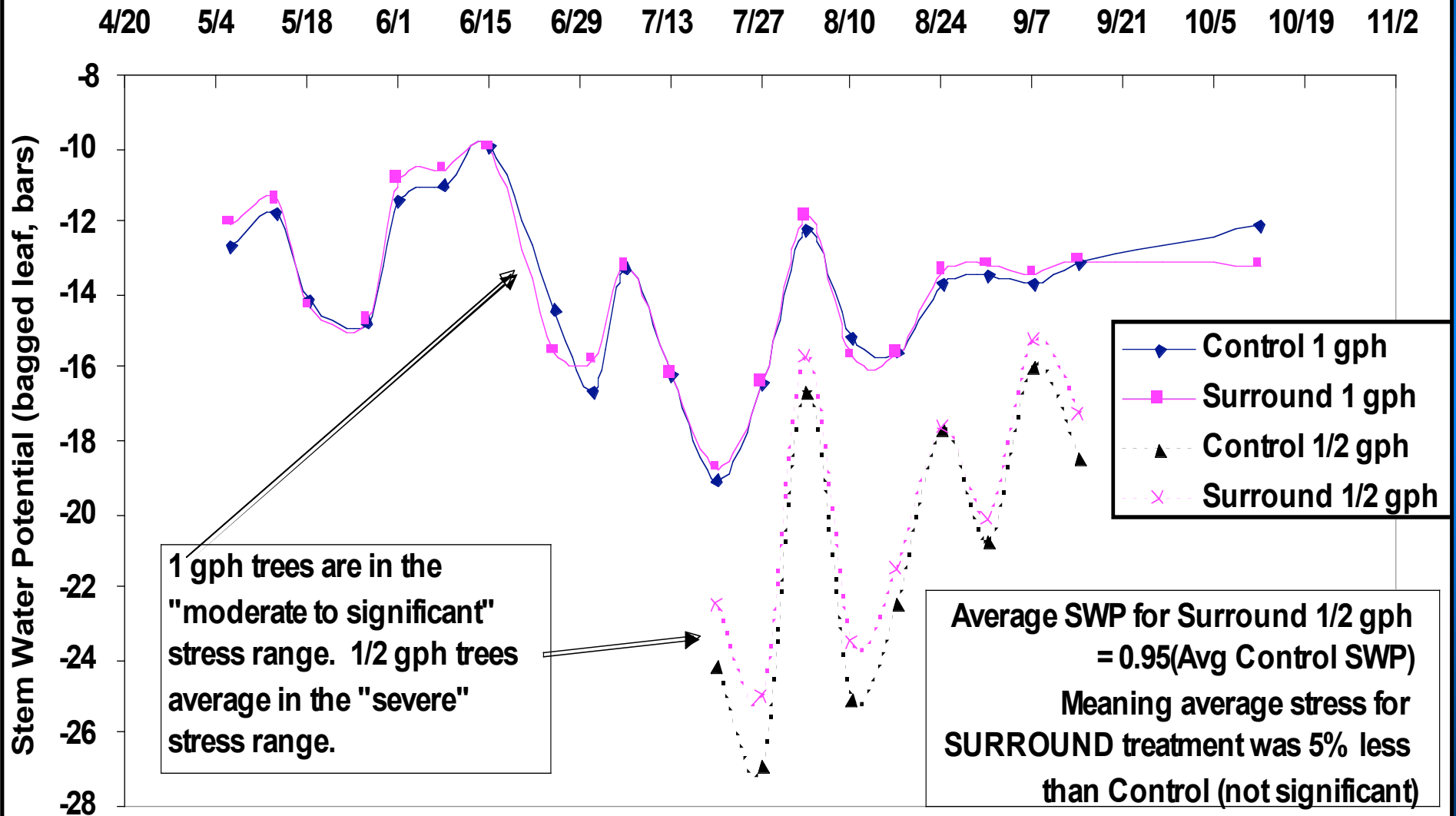
Various cumulative ET and Irrigation for Season



2002 "Zone" and "Mean" calculated ET's compared

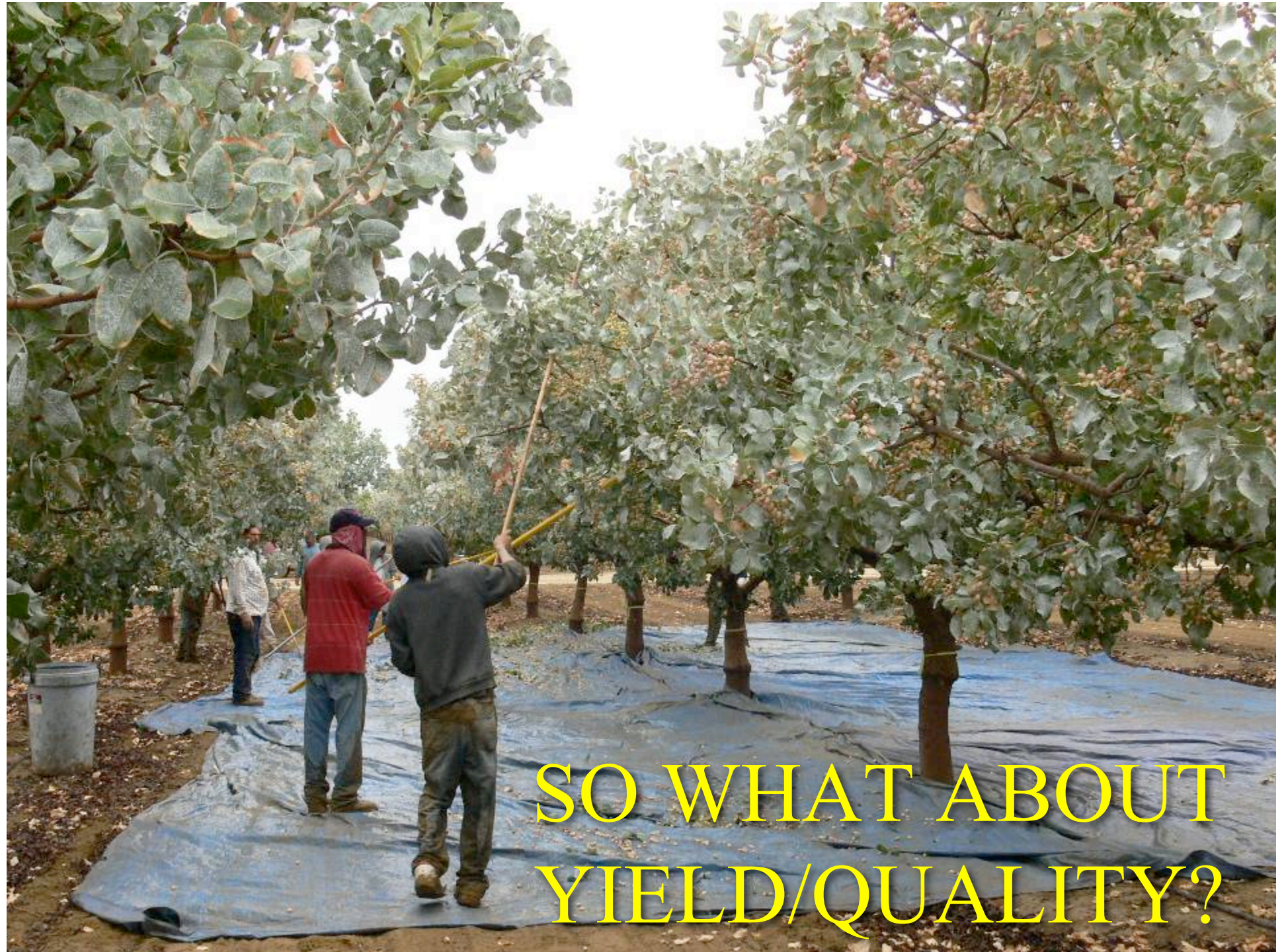


Comparison of tree stem water potential for various treatments and irrigation



SMALL PLOT HIGH-STRESS TREES with $\frac{1}{2}$ gph PC DRIPPERS

Since May-June SWP measurements showed only moderate levels of stress despite apparent deficit irrigation, we decided to create 8 tree subplots in each large plot with a further 50% irrigation deficit starting July 13. The three, 1 gph PC drippers were replaced with $\frac{1}{2}$ gph; changing the applied water rate from 0.34 in/day to 0.17 in/day. This caused an additional -3 to -10 bars of stress more than that experienced by the 1 gph irrigation. The middle 6 of these 8 trees were hand harvested along with 6 corresponding trees with 1 gph emitters 2 rows to the east.



SO WHAT ABOUT
YIELD/QUALITY?

YIELD / QUALITY

WHOLE FIELD PLOT AVERAGES 9/14-19/09	CONTROL		SURROUND		SURROUND / CONTROL
	LB/AC	% T.O.	LB/AC	% T.O.	
TOTAL EDIBLE SPLIT INSHELL	2,630	67.2%	2,638	66.8%	1.00
Total EDIBLE WT. (Split Inshell + Kernel from SS & Closed)	2,853	72.7%	2,839	71.9%	1.00
TOTAL INSHELL WEIGHT	3,076	78.3%	3,041	76.9%	0.99
<i>BLANKS</i>	-720	-17.7%	-762	-19.1%	1.06
<i>TOTAL INSECT from SI &SS</i>	-41	-1.0%	-44	-1.1%	1.08

SMALL PLOT (6 tree) AVERAGES 9/14/09	CONTROL		*SURROUND		SURR/CNT	
	*0.5 gph	1 gph	*0.5 gph	1 gph	0.5 gph	1 gph
TOTAL EDIBLE SPLIT INSHELL	2452	2252	3090	2535	1.26	1.13
Total EDIBLE WT. (Split Inshell + Kernel from SS & Closed)	2598	2342	3246	2687	1.25	1.15
TOTAL INSHELL WEIGHT	2744	2433	3402	2840	1.24	1.17
<i>BLANKS</i>	-699	-574	-809	-687	1.16	1.20
<i>TOTAL INSECT from SI &SS</i>	-19	-37	-24	-28	1.26	0.75

*Significantly different from Control or 1 gph emitters (P<0.05)

Concluding Conclusions:

- **SURROUND does not appear to provide a conclusive water related benefit to pistachios, BUT ...**
- **The trial needs to be repeated for a second year**
- **Dump the satellite data**
- **Reduce main plots to 16 rows to save material, but still large enough for large, truck load yield analysis**
- **Expand ½ gph deficit plots to 4 rows by 12 trees. Machine harvest center 20 trees**

