

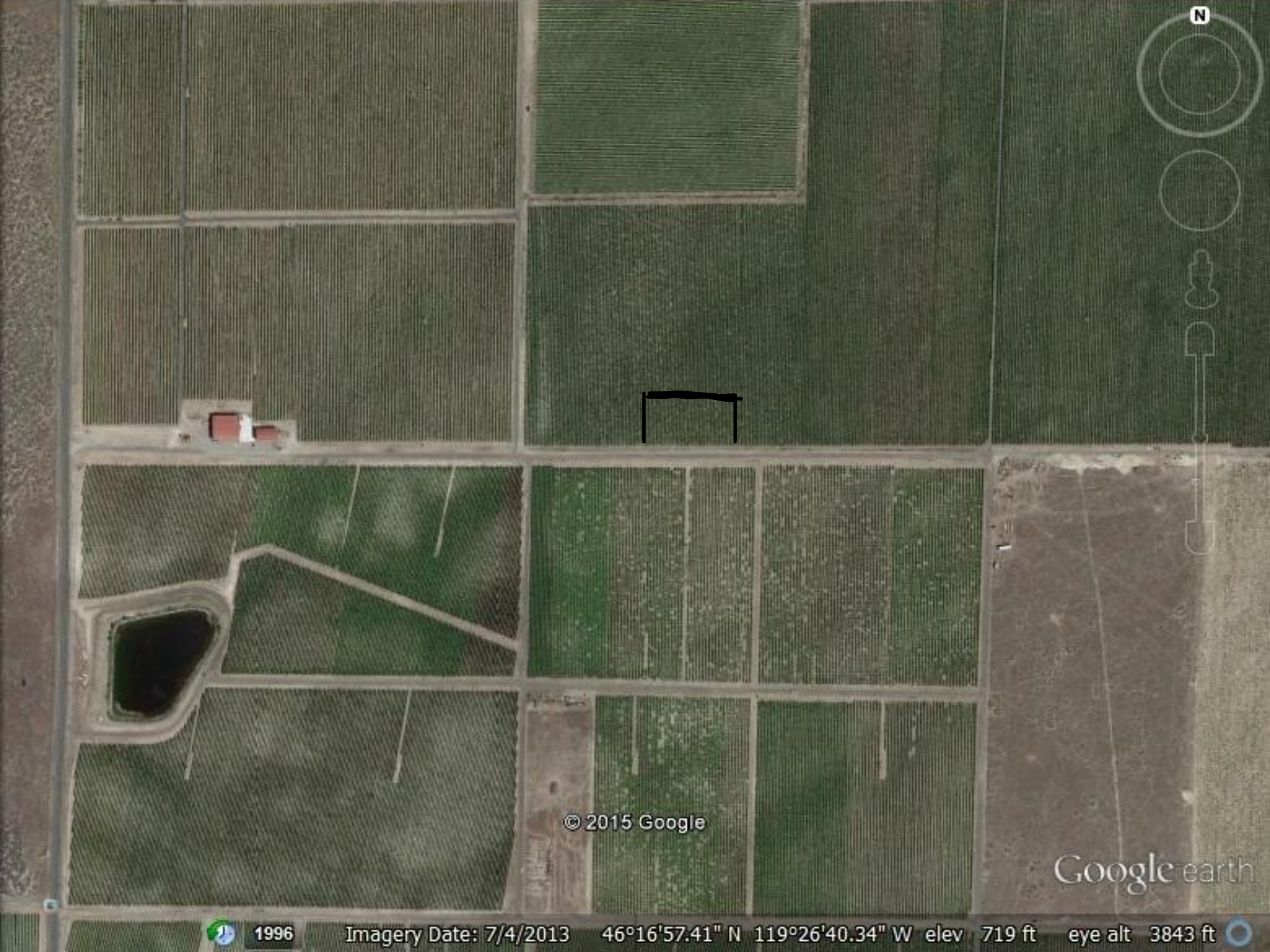
Direct Root-zone (DRZ) Micro-irrigation for Sustaining Vineyards during Drought



Pete W. Jacoby
Professor, Crop & Soil Sciences
Project Leader

Xiaochi (Max) Ma and Jeremy R. Thompson
Ph.D. candidate graduate students

Scott Williams
Kiona Winery and Vineyards
Cooperator



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Google earth



1996

Imagery Date: 7/4/2013

46°16'57.41" N 119°26'40.34" W elev 719 ft

eye alt 3843 ft



Kiona Block 2 - 2016

Write a description for your map.

Legend



Direct root-zone drip irrigation - DRZ (delivered at 1, 2, and 3 feet below surface)



Hypothesis and Research Objectives

Hypothesis: Grapevines can remain productive under subsurface micro-irrigation applied at deep depths within the root-zone while conserving irrigation water.

Objectives:

- Evaluate potential of new technique to deliver drip irrigation into the deep subsurface root-zone
- Determine advantages of the technique to conserve water and enhance grape quality through deficit irrigation
- Evaluate remote sensing to detect plant water stress

Experimental Design

- Randomized Complete Block Design w/ 3 blocks
- Split-plot – contrast continuous and pulsed application technique
- Main Effects
 - Depth of Water Delivery (1, 2, and 3 feet)
 - Application Rate (60, 30, and 15 % of commercial rate) – season-long
- Observations – 15 vines per treatment (3 rows x 5 vines)
- Total vines (27 rows x 30 vines) = 810 treated + 180 commercial vines

Methods employed to assess treatment effect

Electronic controllers – deliver pulsed and continuous water rates

Mechanical water meters – quantify actual water applied per row

Vertical delivery tubes – first proto-type PVC tubes

Syntek soil moisture probes – spot and constant recording

Plant water stress pressure chamber – plant water stress

Remote sensing with infrared and multispectral sensors – stress

Fruit harvest weight – cluster samples for grape size and number

Total plot harvest weights – grape quality panel by ETS labs

Mini-rhizotrons – digital root images for seasonal growth dynamics

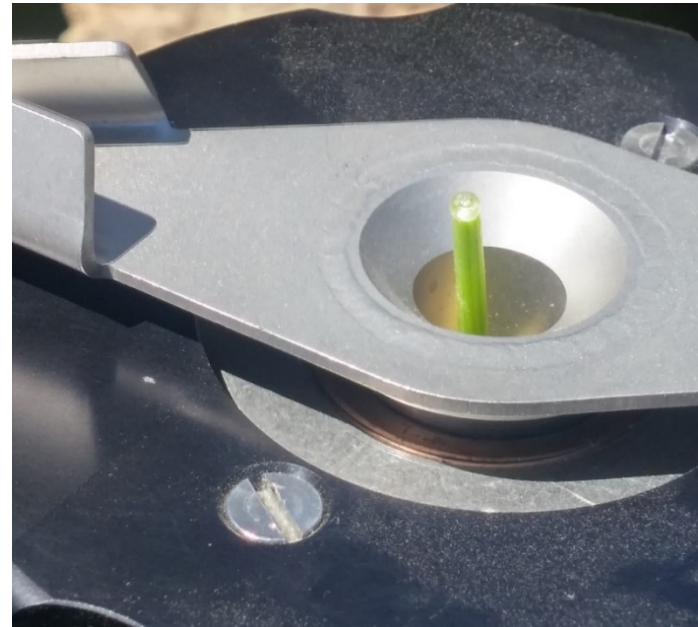
Field portable infrared gas analyzer – stomatal conductance & photosynthesis rates (2017 and beyond)

Electronic Controllers

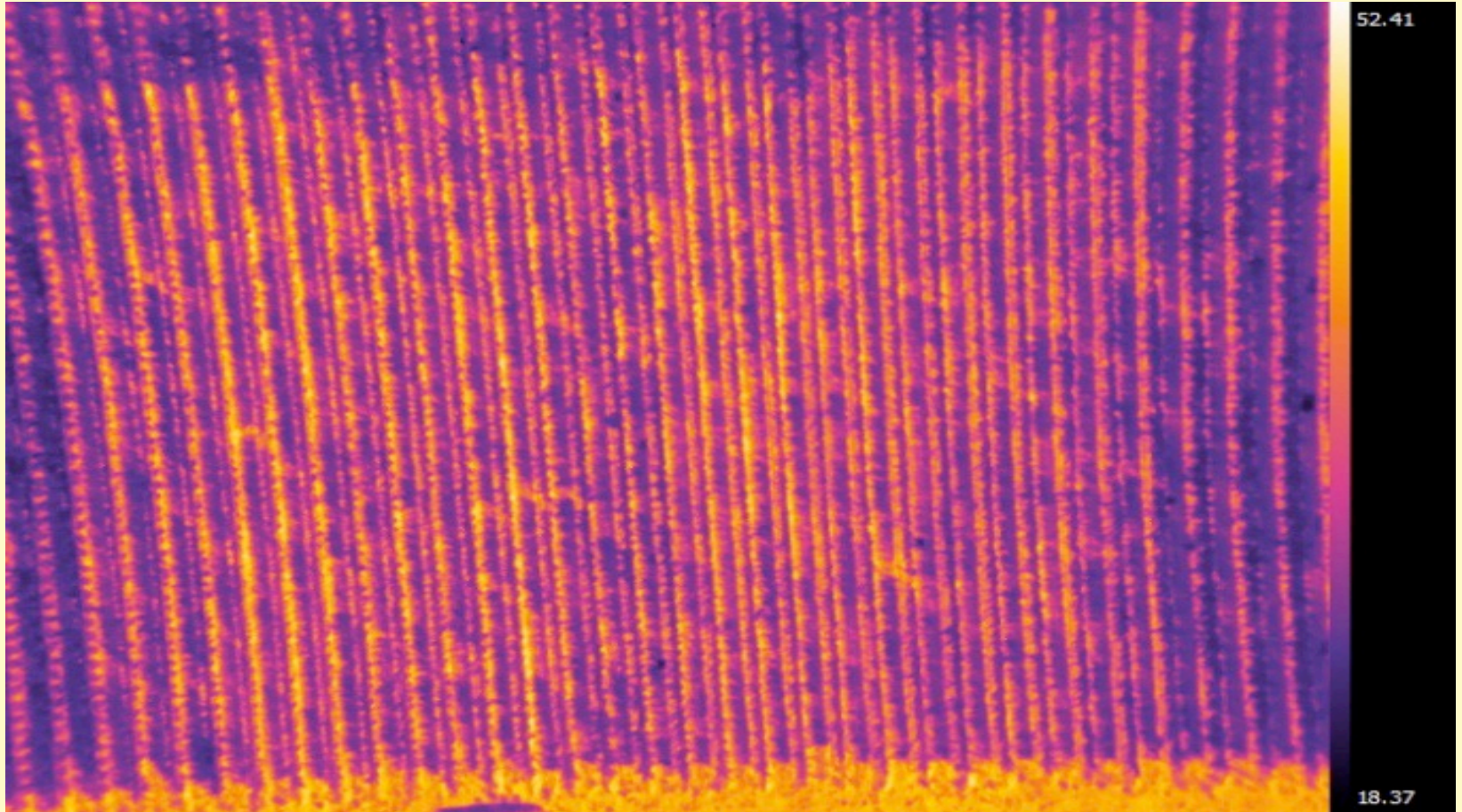


Plant Water Status

Mid-day Stem Water Potential



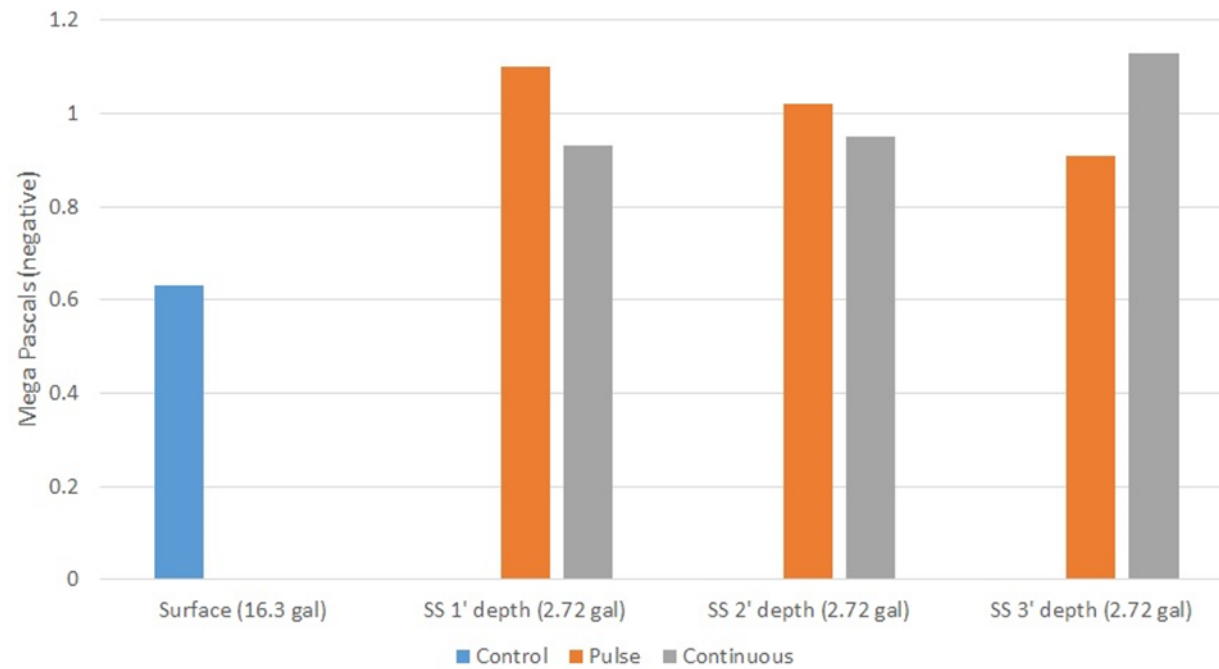
Remote sensing – multi-spectral image
(vines appear as purple – bare ground is yellow)



Mini-rhizotron root imaging system



Mid-day Stem Water Stress Red Mtn. – early veraison



Plant water stress as determined by leaf stem xylem potential during 2016 growing season contrasting commercial surface drip irrigation with season-long deficit irrigation imposed by direct root-zone micro-irrigation delivered subsurface from 1-3' depths at rates of 60, 30, or 15% the rate of surface drip irrigation.

Surface Drip (DI)		Sub-surface Irrigation Treatments		
		-----DRZ-----		
(100 %)		(60 %)	(30%)	(15%)
<u>Date</u>	<u>Xylem Pressure Potential (MPa)</u>			
June 3	-.53	-.59	-.64	-.78
July 7	-.64	-.83	-.93	-1.19
Aug 10	-.87	-1.18	-1.52	-1.59





Grape production (lbs./vine) from plots receiving full commercial irrigation applied as surface drip (SD) and applied as direct root-zone micro-irrigation (DRZ) at season-long reduced rates of ca. 60, 30, and 15 % of full commercial rate during 2015 and 2016. Irrigation rates were consistently higher in 2016, although time periods of application remained the same for both years.

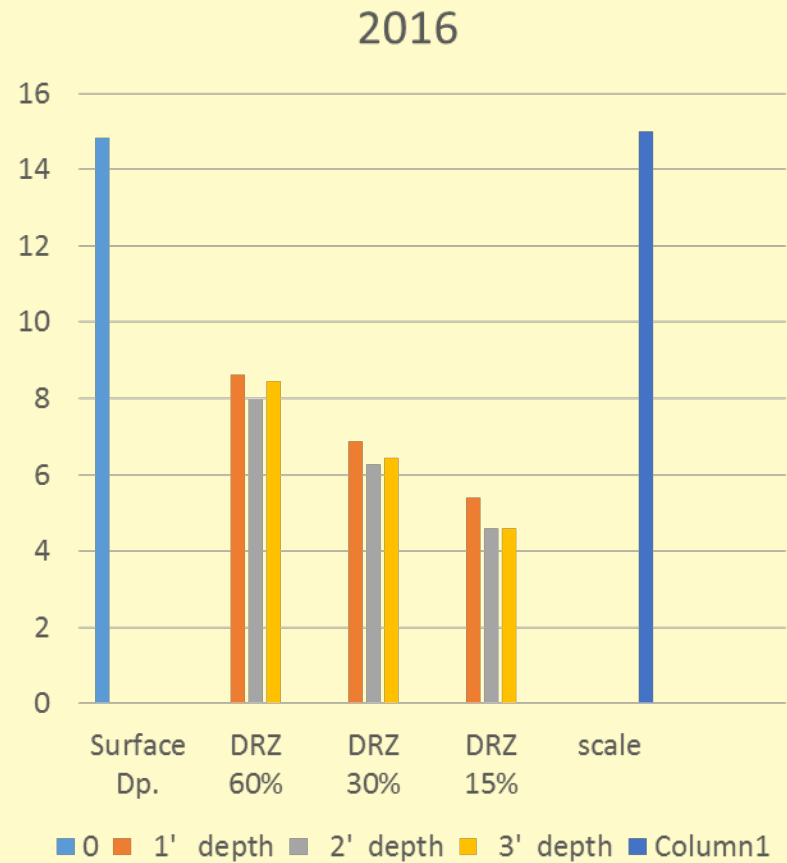
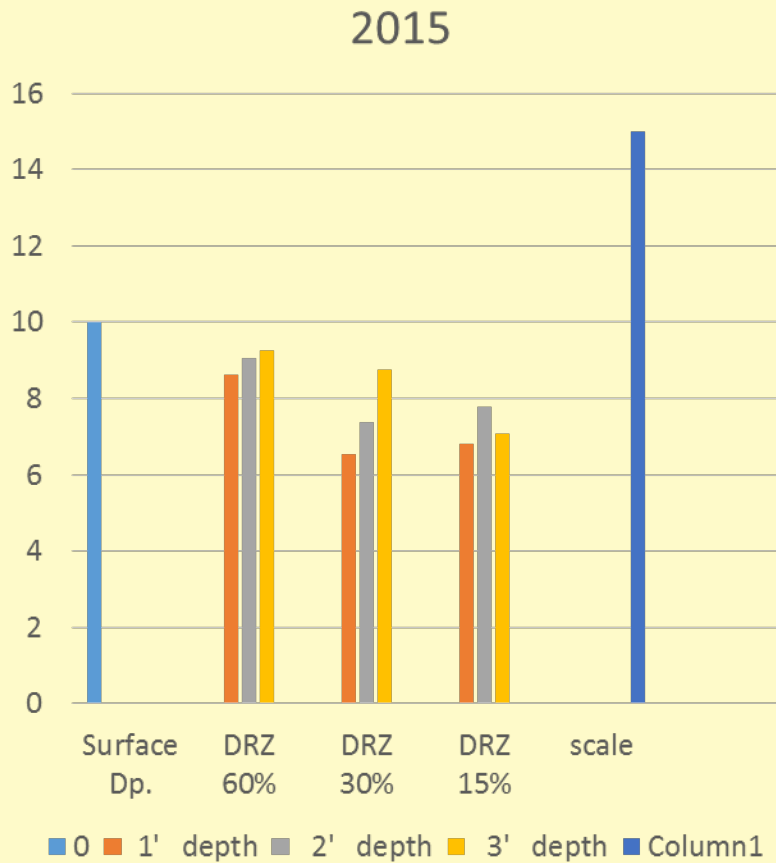
	Irrigation Treatments							
	Surface Drip (DI)		-----DRZ-----					
	(100 %)		(60 %)		(30 %)		(15 %)	
	----- Wt. per Vine (lbs) -----							
	<u>2015</u>	<u>2016</u>	<u>2015</u>	<u>2016</u>	<u>2015</u>	<u>2016</u>	<u>2015</u>	<u>2016</u>
Surface Drip	10.0	14.8						
DRZ at -1'				8.6	8.6	6.6	6.9	6.8
5.4								
DRZ at -2'			9.1	8.0	7.4	6.3	7.8	4.6
DRZ at -3'			<u>9.3</u>	<u>8.5</u>	<u>8.8</u>	<u>6.4</u>	<u>7.1</u>	<u>4.5</u>
Mean	10.0	14.8	9.0	8.4	7.6	6.5	7.2	4.9

Seasonal irrigation delivery and water use efficiency based on grape production during 2015 and 2016 comparing commercial surface drip irrigation with season-long deficit irrigation imposed by direct root-zone micro-irrigation delivered subsurface from pooled depths at rates of 60, 30, or 15% the rate of surface drip irrigation.

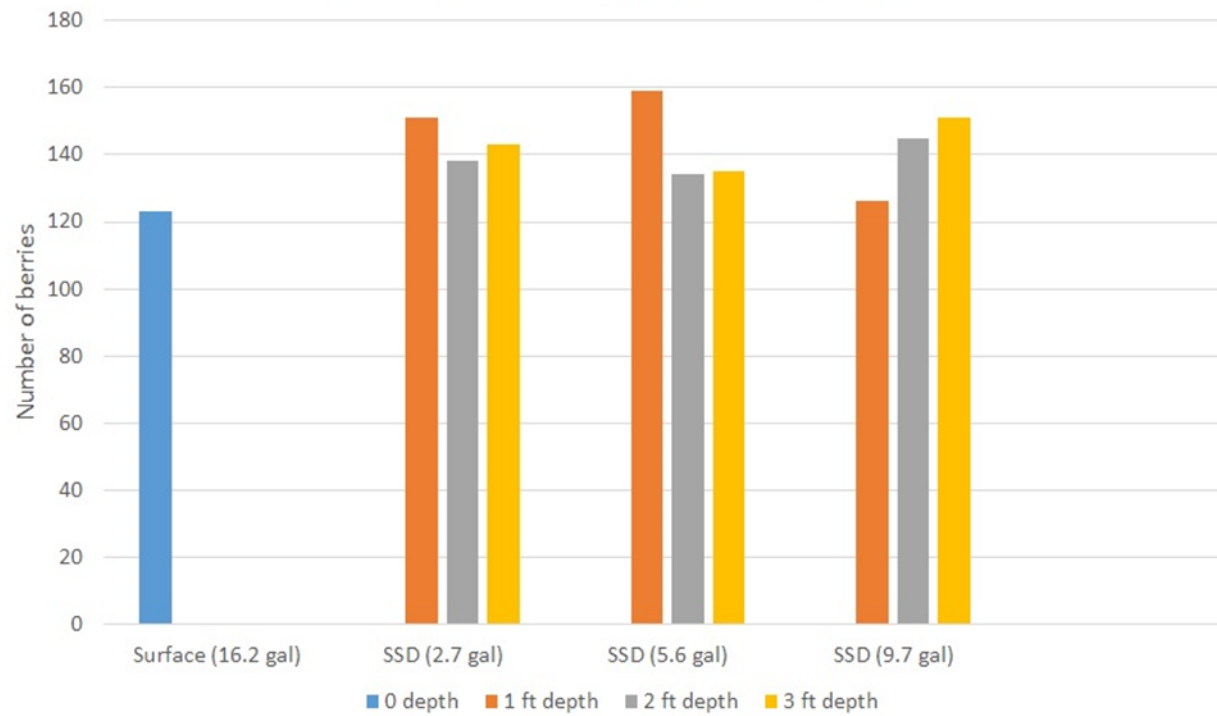
	Surface Drip (DI)	Irrigation Treatments		
		-----DRZ-----		
	(100 %)	(60 %)	(30%)	(15%)
<u>2015</u> Water Use (acre ft.)	1.35	0.81	0.40	0.20
Water/vine each event	16.25	9.75	4.88	2.44
Grape production (tons/ac)	4.54	4.08	3.40	3.18
Production Efficiency (lbs./acre inch applied)	560	840	1400	2650
Relative Efficiency	1.0	1.5	2.5	4.7

<u>2016</u> Water Use (acre ft.)	1.37	0.84	0.43	0.23
Water/vine each event	17.59	10.27	5.13	2.57
Grape production (tons/ac)	6.73	3.79	2.96	2.20
Production Efficiency (lbs./acre inch applied)	818	752	1147	1598
Relative Efficiency	1.0	0.9	1.4	2.0

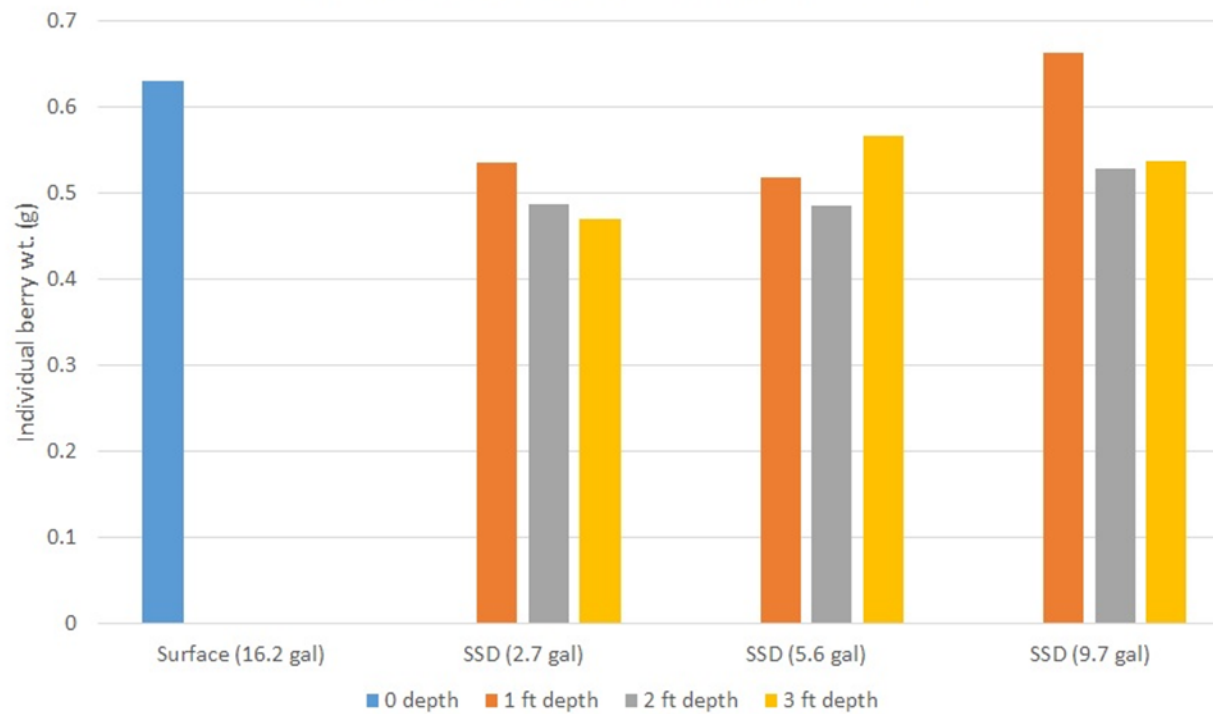
Average Harvest Weight per Vine (lbs.)



Berries per Cluster
Control vs. SSD Constant – Reduced Rates



Individual Berry Weight (g)
Control vs. SSD Constant – Reduced Rates



2015 Findings

- 70-90 % the production of commercial production
- 40 – 85% water savings over commercial practice
- Higher numbers of berries per cluster and smaller individual berries
- Questions about wine quality and sustained vine health

Grape quality measurements at end of growing season (2016) comparing surface drip (commercial rate) and direct root-zone (DRZ) subsurface drip irrigation delivered at 3 reduced rates at 2 feet below surface.

Component	Surface drip (100 %)	DRZ (60 %)	DRZ (30 %)	DRZ (15 %)
pH (acidity)	3.41	3.36	3.48	3.55
Titrateable Acidity (g/L)	5.5	5.8	5.3	4.9
Brix (degrees)	25.5	27.1	27.6	28.6
Tannins (mg/L)	403	594	600	741
Anthocyanins (mg/L)	1015	1242	1298	1480

Carbon partitioning research

(Proportions to above
and below ground)

\$25,000 awarded for
graduate student
research from
Western Sustainable
Agriculture Research
and Education
(WSARE)



DRZ Plots at Hogue Ranches, Prosser, WA

Chardonnay wine grapes



Preliminary Results – 2016 Growing Season

Hogue Ranches (Blk 112) Chardonnay

- End of season Yield data showed no differences among depths of DRZ micro-irrigation or between DRZ at reduced rates and SD at full rate (except at 2' depth, rate response)
- Full irrigation SD yield was 10.77 lbs/vine compared with 11.0, 9.3, and 10.5 lbs/vine for DRZ at 60, 30, and 15% of full SD rate (100%).

TRT	BRIX	pH	<u>Titrateable Acidity (g/L)</u>
100% SD	21.1	3.29	7.6
60% DRZ	21.6	3.31	7.1
30% DRZ	22.3	3.32	6.9
15% DRZ	22.6	3.44	5.8

Summary of findings to date

- Season-long deficit irrigation applied through DRZ micro-irrigation demonstrated promise to produce high quality grapes with reduced rates of water applied through current state-of-the-art techniques
- No obvious and consistent impacts were observed to justify pulsed irrigation techniques over continuous water applications
- No obvious and consistent impacts were attributed to application of sub-surface irrigation at any of the particular depths used to date
- Additional data analyses will be performed on root images and data on photosynthesis data to be obtained during 2017
- Additional data will be obtained on grape quality after 2017 harvest
- Consideration is being given to consolidate treatments during 2017 to obtain greater amount of grapes for wine-making and adjust rates and timing of deficit irrigation; also apply pressure regulators to lines