Demonstrating how Frequent Applications Boost N Recovery by Oranges with Grower Operational Records, Actual Evapotranspiration, Soil, and Plant Tissue Data

Background and Objectives

High-frequency, low-rate (HFLR) irrigation systems (i.e., drip and microspray) are increasingly common in California. They are often cited as a management practice to increase both water and nitrogen use efficiencies (WUE, NUE). However, system operation strongly influences WUE and NUE, so the potential benefits of widespread HFLR infrastructure can only be realized if the systems are operated in modes that allow the achievement of these goals.

Objective: Identify opportunities to improve production and environmental outcomes based on detailed operational, soils, and ET information for a 29-acre block of Atwoods.

Methods

- **Location**: medium-sized farm on the Kings River fan near Fresno, California, with 29 acres of Atwood oranges with significant north-south heterogeneity (Figure 1).
- Leaching assessed with site-specific ETa and soil sampling.
- Soil survey and operational information, were used to better understand site-specific performance and identify specific management shifts.
- 3 fields served by a single pump without isolation valving. Modified to facilitate isolated operation & to add flow meter.
- ETa (Paul et al, 2016) for the fields for a 7-year period, along with soil nitrate and salinity (ECe) profiles and leaf tissue N (both from 2017), provided multiple, independent indicators of management and outcomes.
- Grower evaluated production & environmental outcomes and increased irrigation & fertigation frequency while sharply reducing overall amounts.

Results

- Preliminary indicators only:
  - Maintained soil moisture in adequate range without triggering evident drought stress.
  - Field is producing more vigorous growth in better and poorer areas, tissue N sufficient.

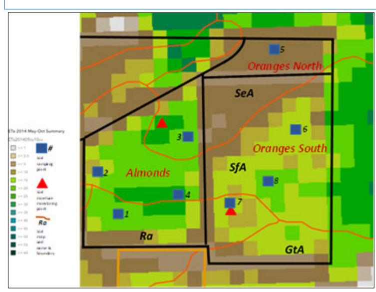


Figure 1. Paul et al. (2016) used a Surface Energy Balance Algorithm (SEBS) to estimate ETa from California's irrigated lands, and this map shows ETa from the 2014 season, with permanent soil sampling locations selected within the dominant soil mapping units.

Table 1. Soil analsis indicating downward nitrate and salinity mobilization in 2017.

	Nitrate (lb/a)		EC (dS/m)	
Date	Top ft	2-6 ft	Top ft	2-6 ft
Mar-17	66	301	1.2	0.8
Jun-18	23	58	0.6	0.5
Aug-18	27	63	0.7	0.5
Mar-18	50	154	0.5	0.5
Jul-18	41	68	0.5	0.5
Aug-18	38	73	0.7	0.7

Table 4. Effect of irrigation frequency on application depth. Note that 2.1 inches fills 75% of the profile's AWC in half the field.

Parameter	Units	2017	2018
Runs/week (April - Sept)	#	1.0	1.8
Max run time	h	48	15
Average run time	h	31	10
Upper estimate @ max run time	in	2.1	0.6
Lower estimate @ max run time	in	1.0	0.3
Upper estimate (April - Sept)	in	35	21
Lower estimate (April - Sept)	in	17	10

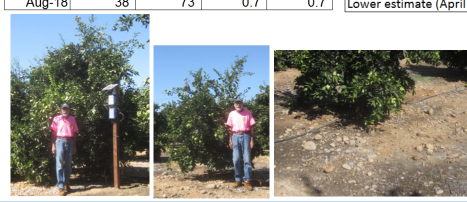


Figure 2. Grower with trees in strong southern, and poor, gravelly northern section of field. Note stunted tree in middle frame. All trees exhibit more new growth than previously during 2018.

Results (cont.)

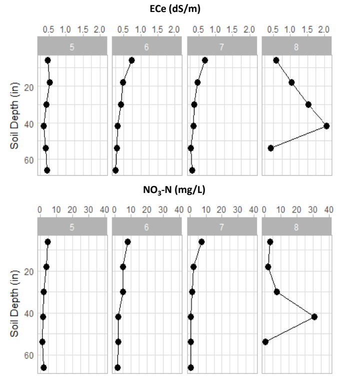
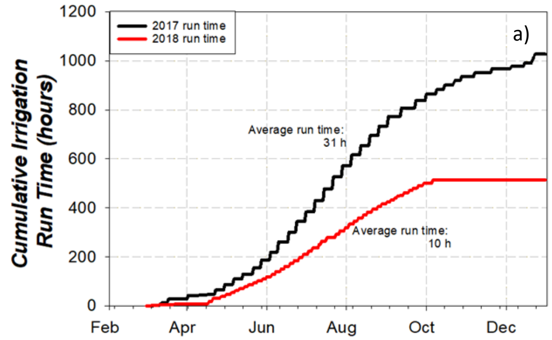


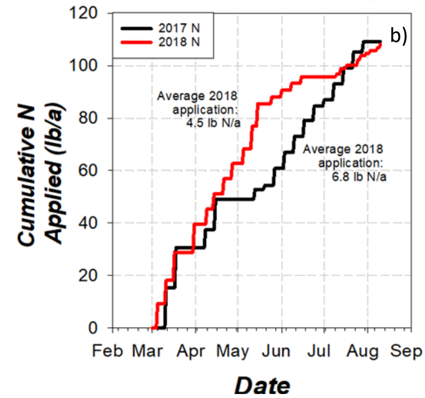
Figure 3. June soil EC$_e$ and nitrate profiles from representative, permanent soil sampling locations.

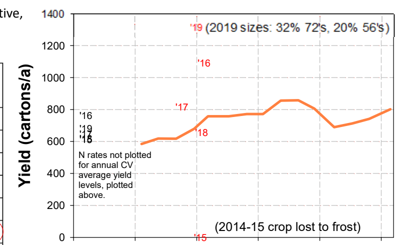
Table 2. Field soil AWC.

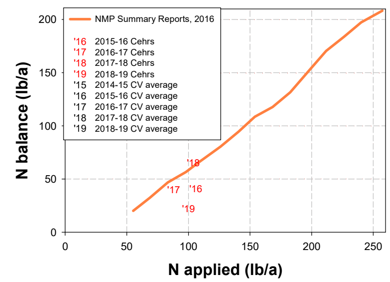
Mapping Unit	AWC36[a]	Area	
(NRCS)	(in)	(acres)	(% of field)
Ra	4.9	3.2	11%
Rc	5.2	3.2	11%
SeA	3.0	0.1	0%
SfA	5.3	9.1	31%
GtA	2.8	13.5	46%
Total		29.1	

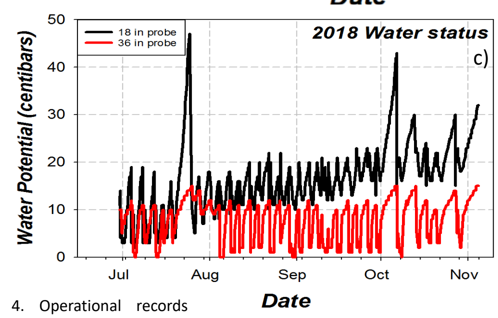
[a]AWC in the orange root zone, which is estimated to extend to about 36 inches depth.











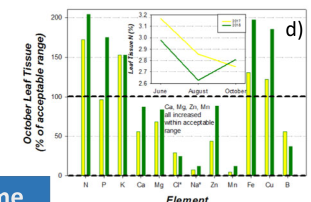


Figure 4. Operational records indicate a sharp shift to more frequent and overall reduced rates of N and water (a & b), yet soil moisture & nutrition appear adequate (c & d), & tree vigor improved. As a result, yield and N balance, already good by industry standards, markedly improved (e).

Table 3. Running Atwoods and two other blocks together may drop pressures & application rates.

Parameter	Units	All 3 on	Almond	Atwood
Area	acres	68	18	28
Volume	a-f	2.83	0.64	0.92
Run time	h	21.5	8	7.5
Application rate	a-f/h	0.13	0.08	0.12
(flow meter)	in/h	0.02	0.05	0.05
Design rate	in/h	0.043	0.043	0.043
Ground measured rate	in/h		0.021	0.021

Yet to Come

- Analyze 2018 soil and plant tissue results relative to management shifts and production information.
- Evaluate production outcomes and identify needed adjustments.
- Investigate opportunities to independently operate the 3 fields depending on a single pump.
- Once long-term practices are identified, modify infrastructure to render them sustainable and replicable.

SSJV MPEP Committee Coalitions

Buena Vista Coalition
Cawelo Water District Coalition
Kaweah Basin Water Quality Association
Kern River Watershed Coalition Authority
Kings River Watershed Coalition Authority
Tule Basin Water Quality Coalition
Westside Water Quality Coalition

USDA NRCS Conservation Innovation Grant

The SSJV MPEP Committee was awarded $2 million from the USDA NRCS Conservation Innovation Grant program to increase the use of management practices that reduce nitrate leaching. Growers' and cooperators' contributions will match or exceed this funding.

Contacts

Donald Ikemiya
Technical Coordinator
SSJV MPEP Committee
(559) 636-1166

John Dickey
Technical Program Manager
PlanTierra, LLC
916-517-2481

Acknowledgements

Co-authors: John Dickey, Mike Sowers, Ken Cassman (MPEP Team), David Cehrs (Grower), Thomas Harter (University of California Cooperative Extension [UCCE])
Collaborators: Dan Munk, Mae Culumber,
Support, funding and ETa dataset: South San Joaquin Valley Management Practices Evaluation Program, the Natural Resources Conservation Service (through a Conservation Innovation Grant). ETa dataset provided by Formation Environmental. Formation Environmental developed a statewide coverage of actual ET with a 30 x 30 meter (pixel) resolution (approximately five measurements per acre) using the CalETa platform. CalETa uses peer-reviewed models, satellite input data and ground based meteorological data (CIMIS).

References

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Paul, G., Schmid, B., Hawkins, T., Chong, C.S., Roberson, M., Williams, D., Smith, A. 2016. California Statewide Regional and field Scale Evapotranspiration Mapping Using MODIS & Landsat, and Surface Energy Balance System (SEBS). ASA-CSSA-SSSA International Annual Meeting, November 6–9, 2016, Phoenix, AZ.