Managing Soil Moisture for Produce Yield and Quality

Presented by

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Saline Soils

USU Lab Sample	Total (mg/L)	Salts (tons/ac-ft)
1	18,723	25.5
2	17,610	23.9
3	467	0.6
4	17,940	24.4
5	18,379	25.0
6	20,612	28.0

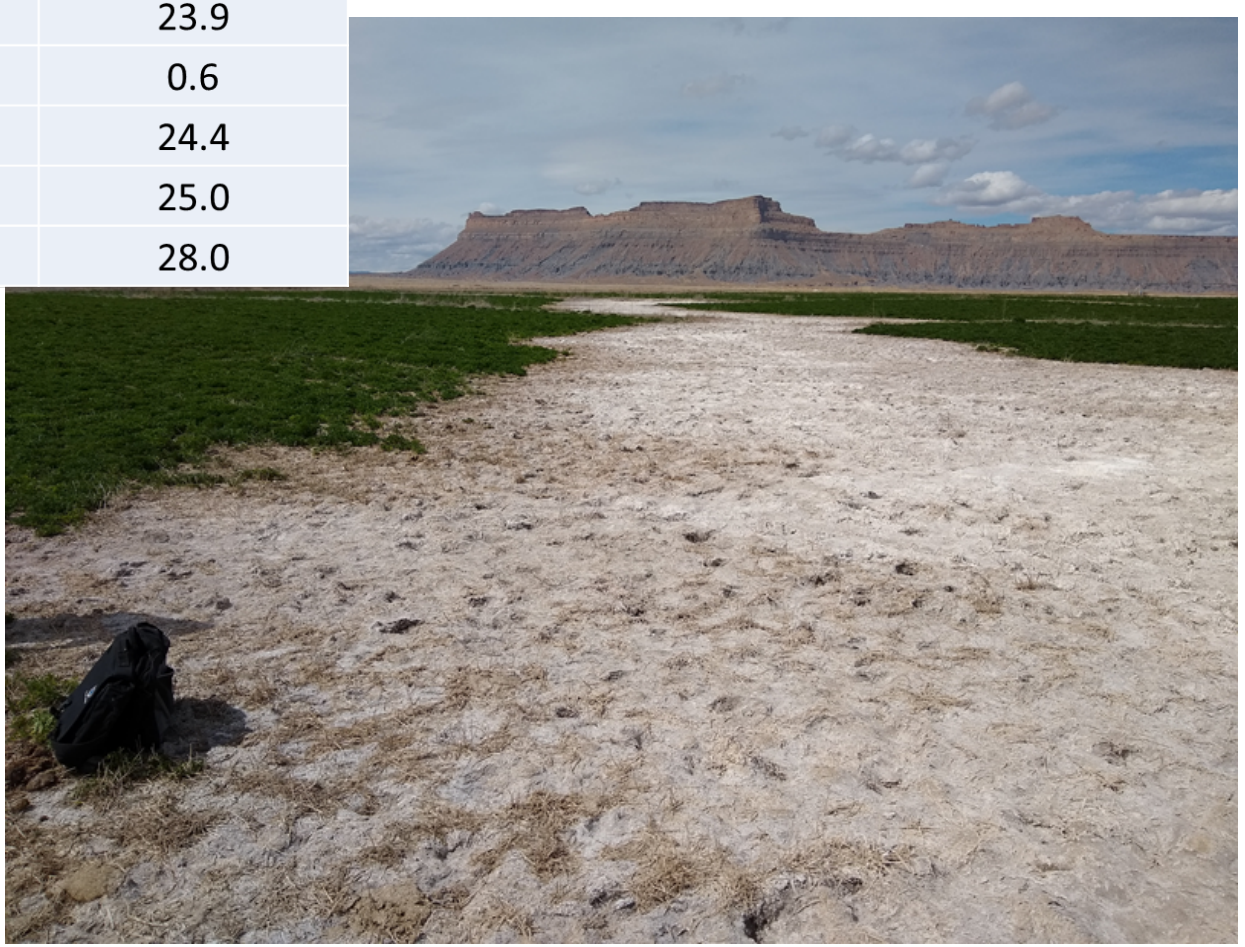
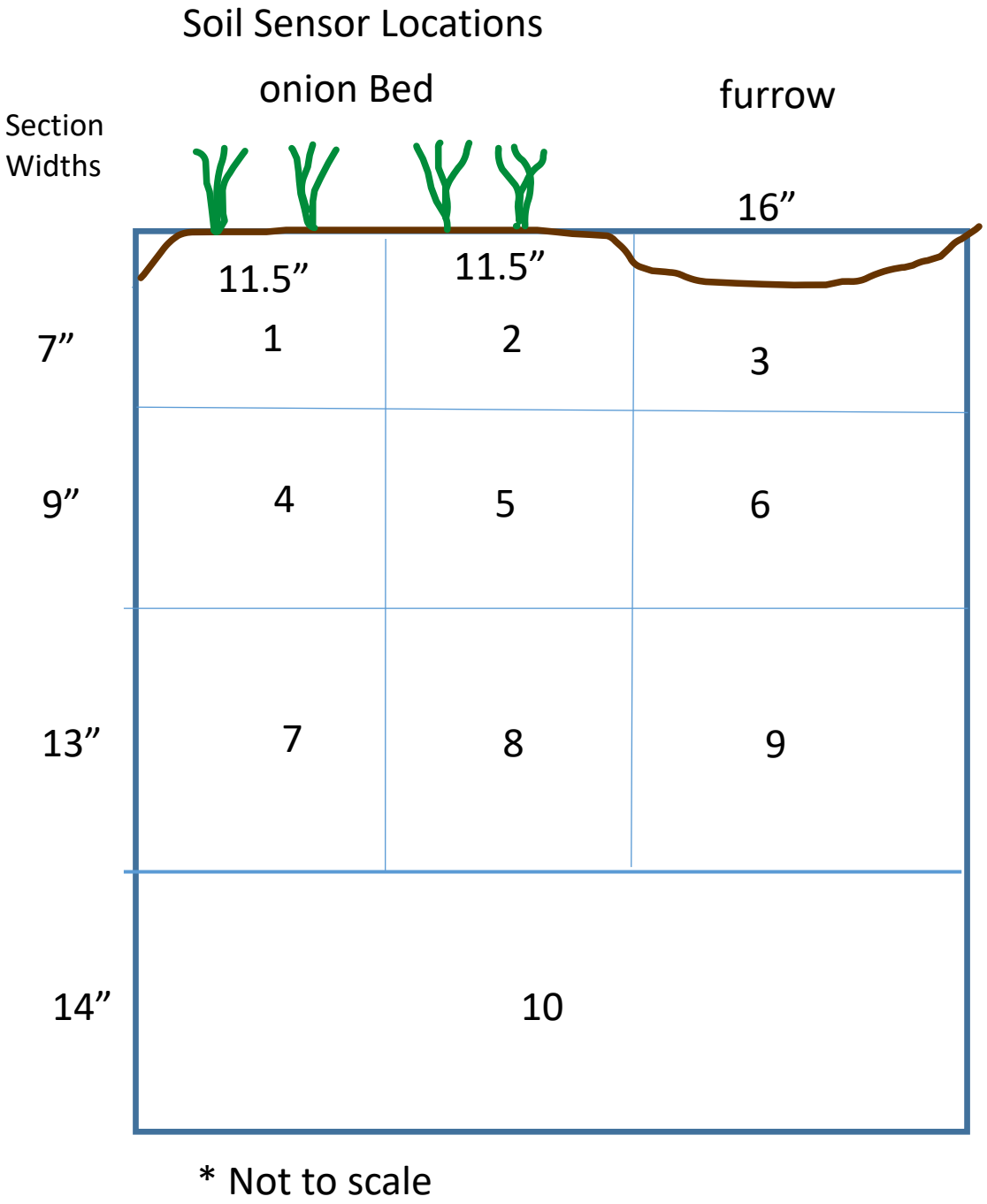


Photo taken April 4, 2019 by Niel Allen

Factors affecting produce yield and quality

- Genetics
- Climate
- Disease
- Pests
- Fertility
- **Soil moisture**



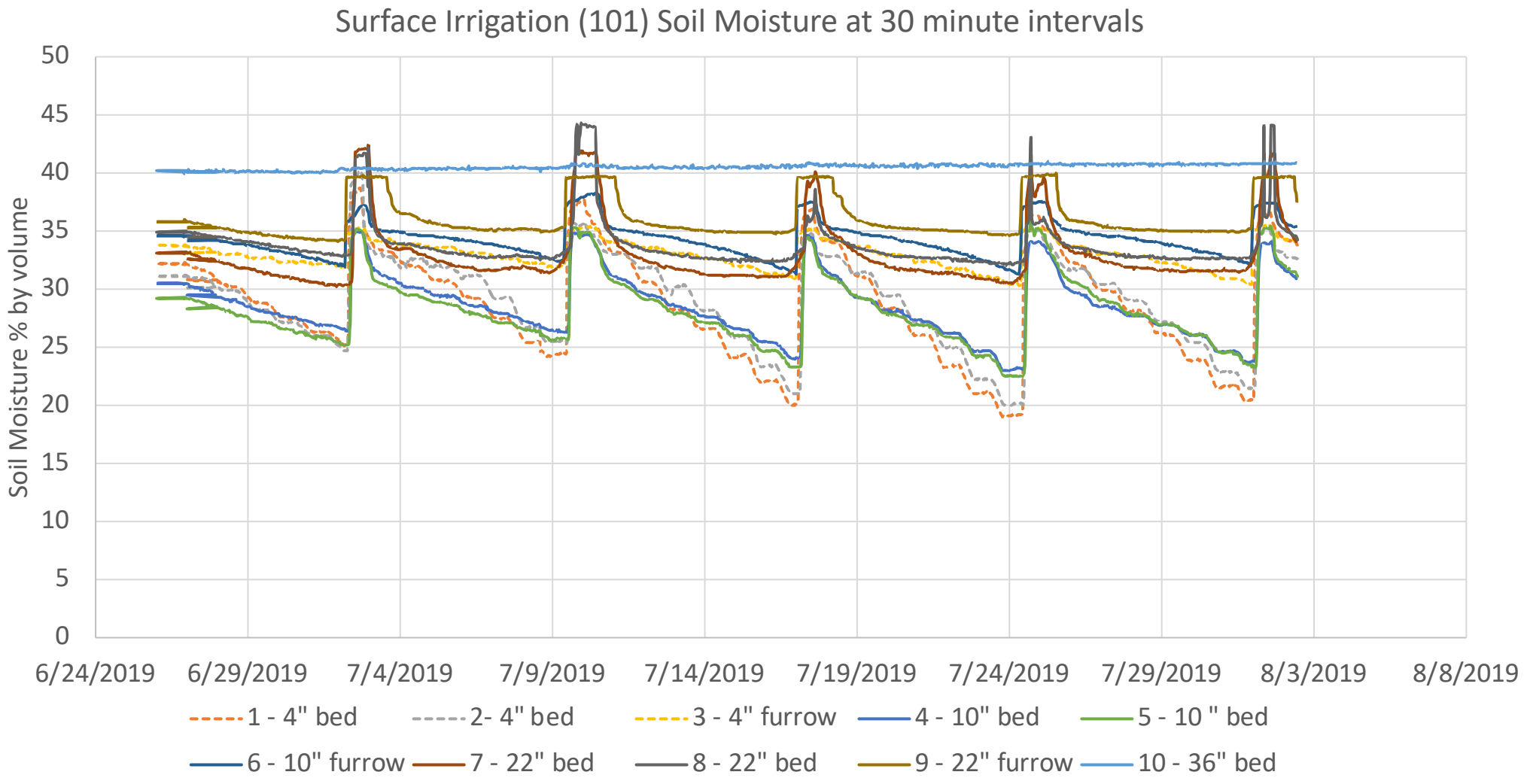
Location of soil moisture sensors (1 through 10)

Each sensor represents a block of soil

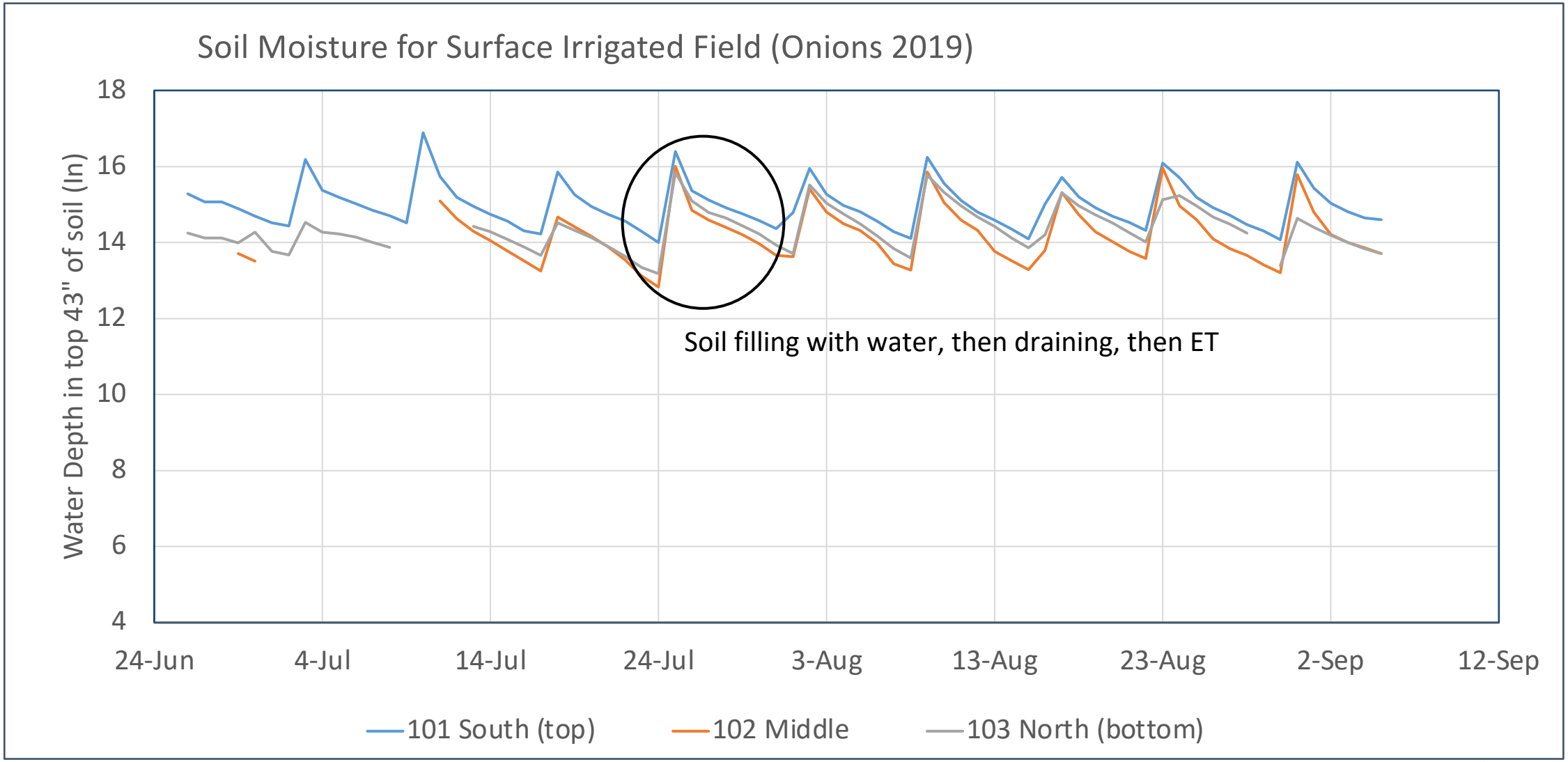
Sensor reads soil moisture in % by volume (e.g. depth = % soil moisture * volume / area)

Measuring Soil Moisture to Estimate ET

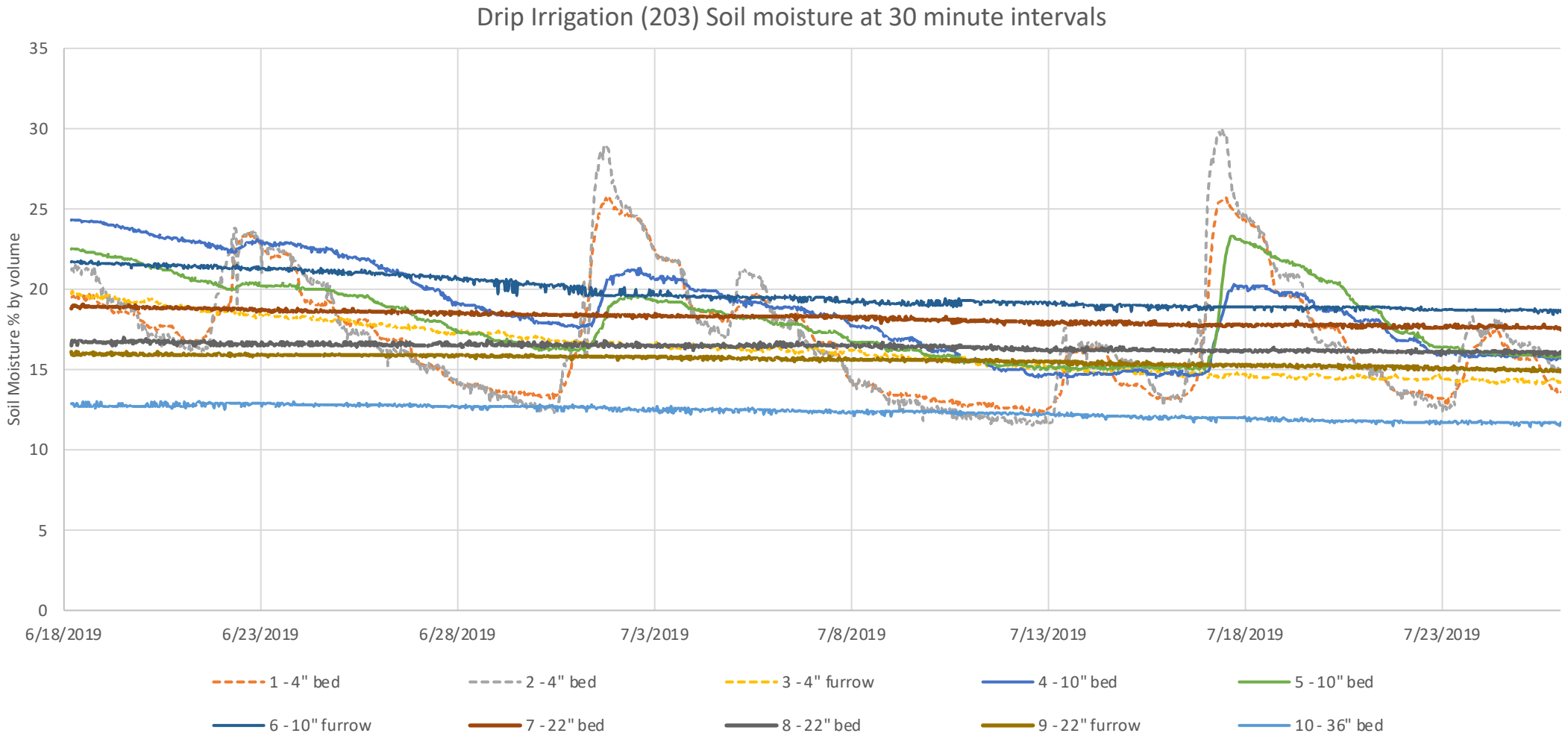
Water use under the bed is the highest



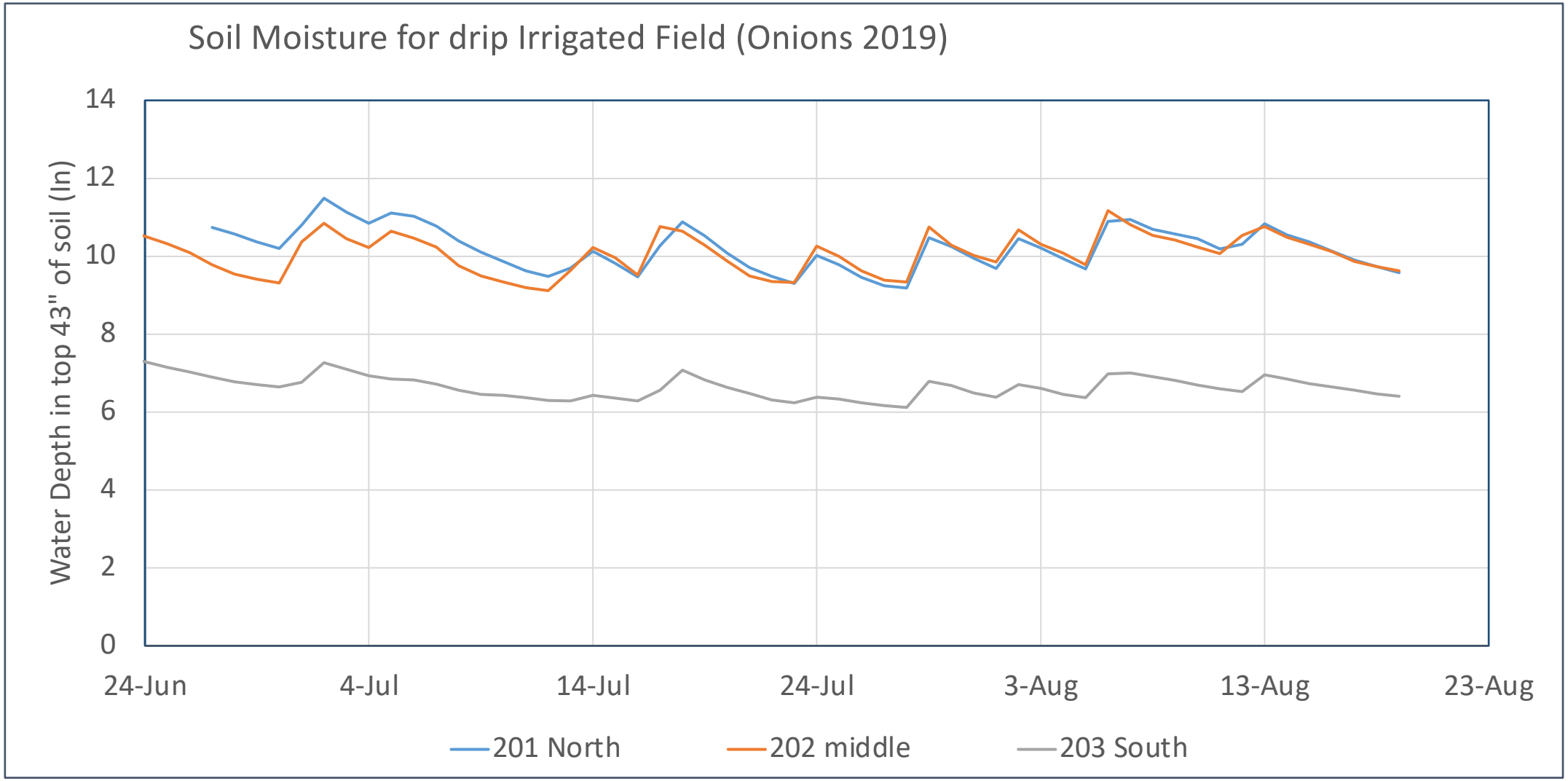
Average Daily Soil Moisture for Surface Irrigation

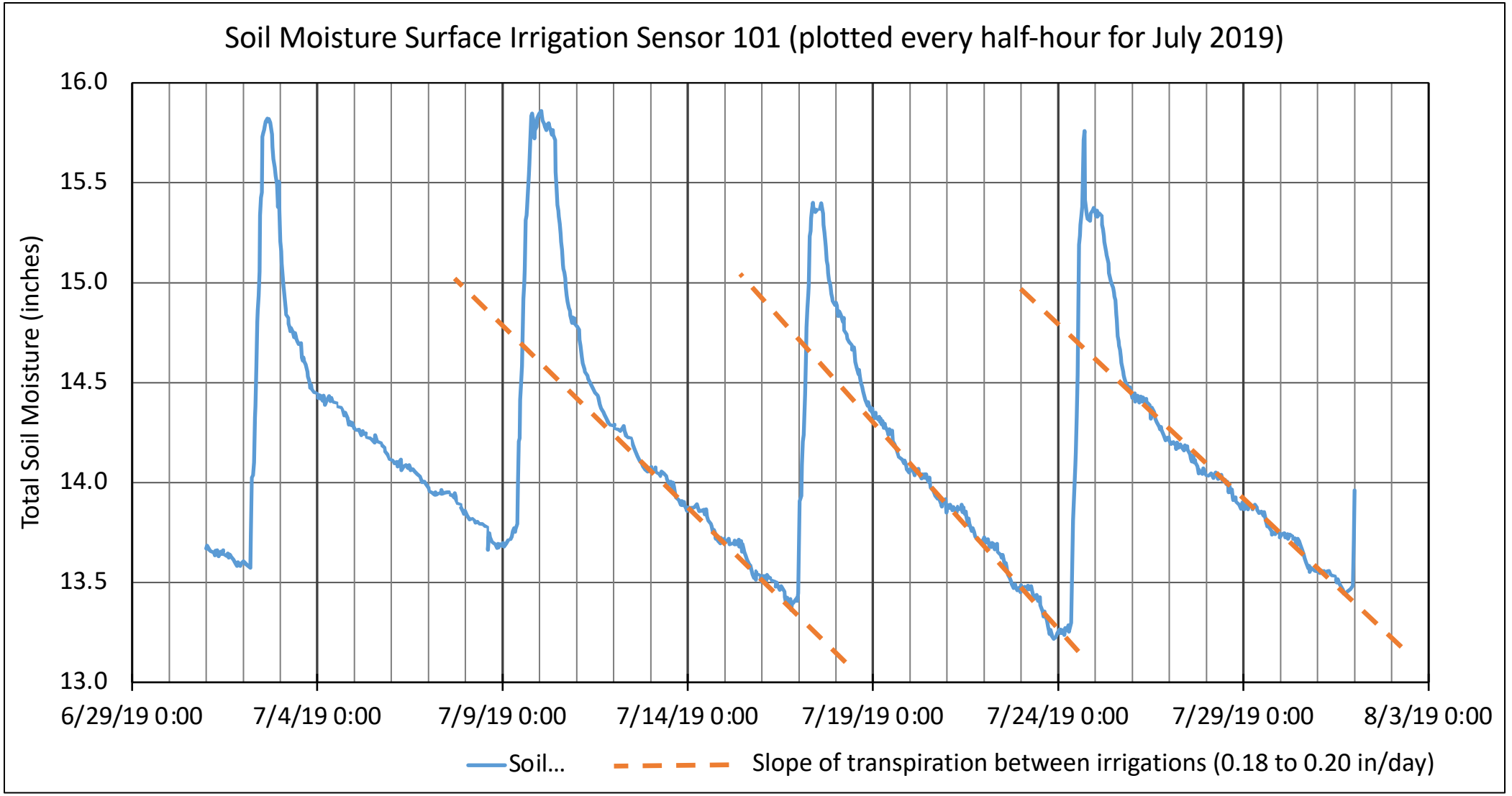


Measuring Soil Moisture to Estimate ET



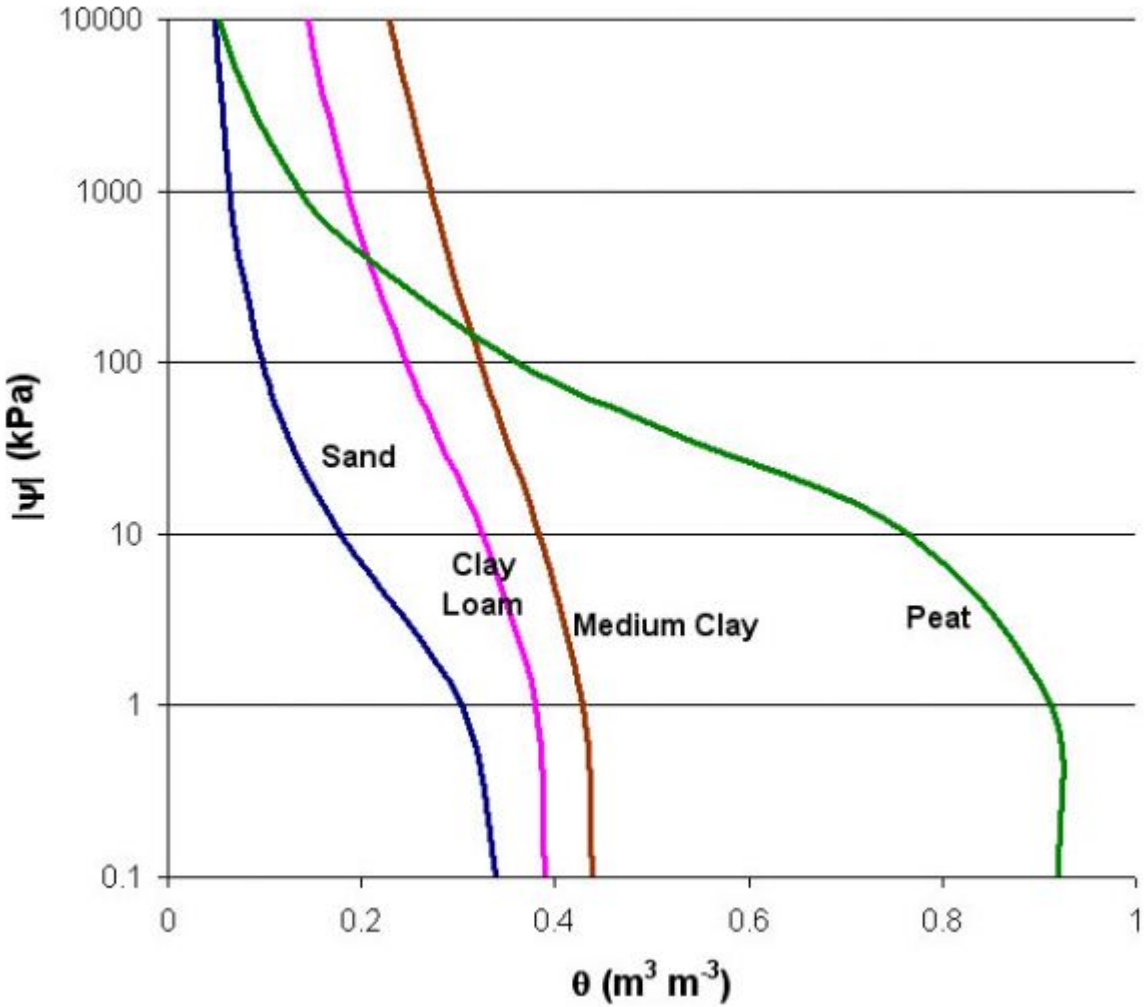
Average Daily Soil Moisture for Drip Irrigation

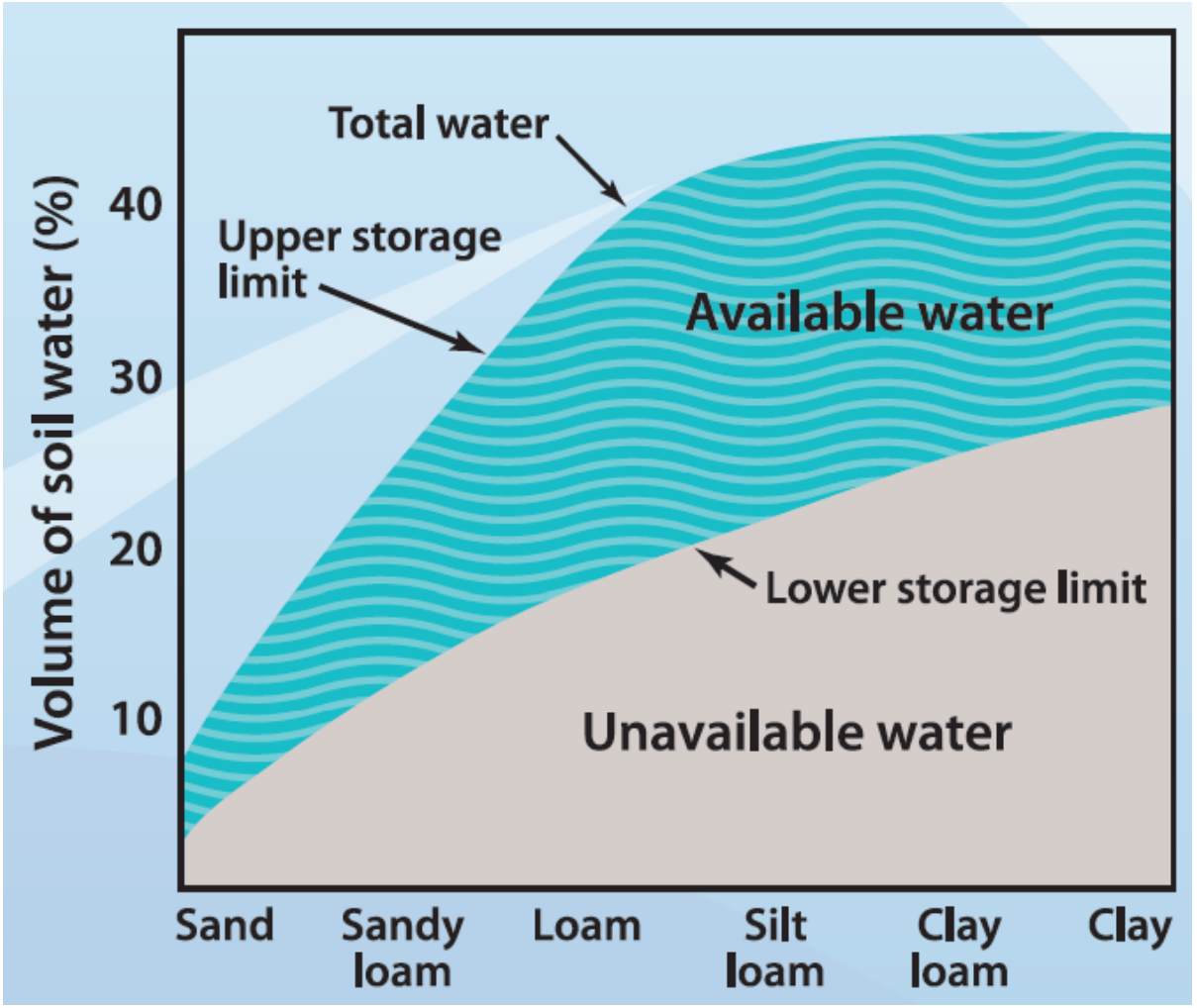




This does not include all evaporation for soil surface

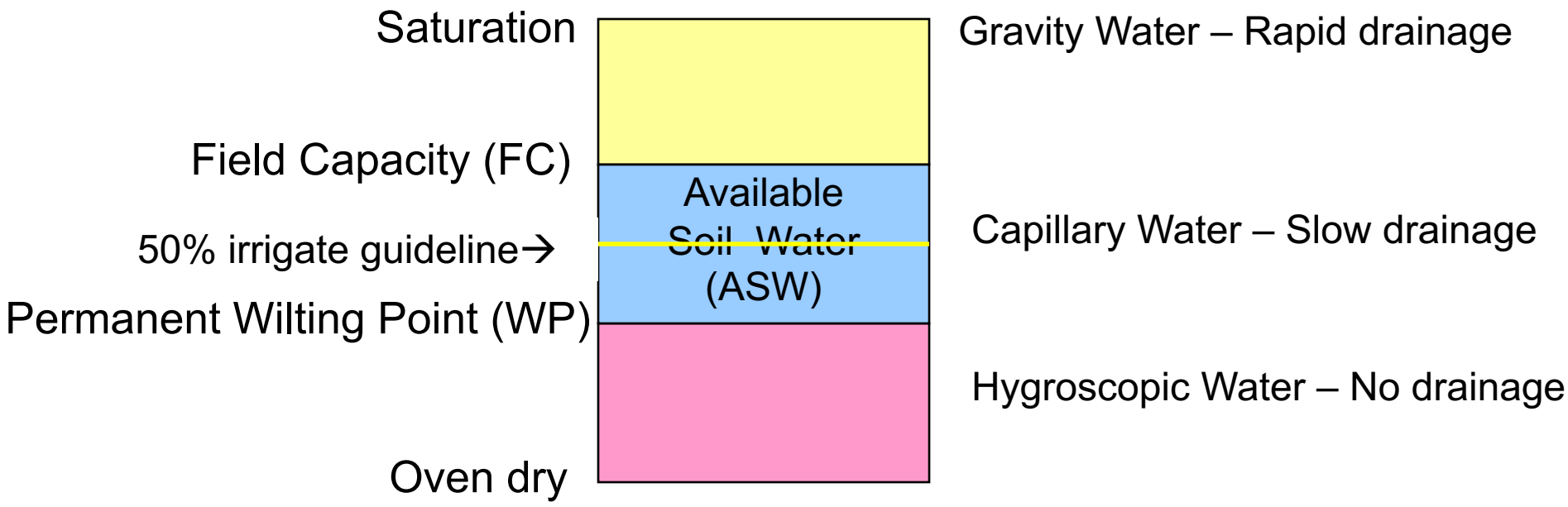
Soil Pore space (conceptual every soil is different)



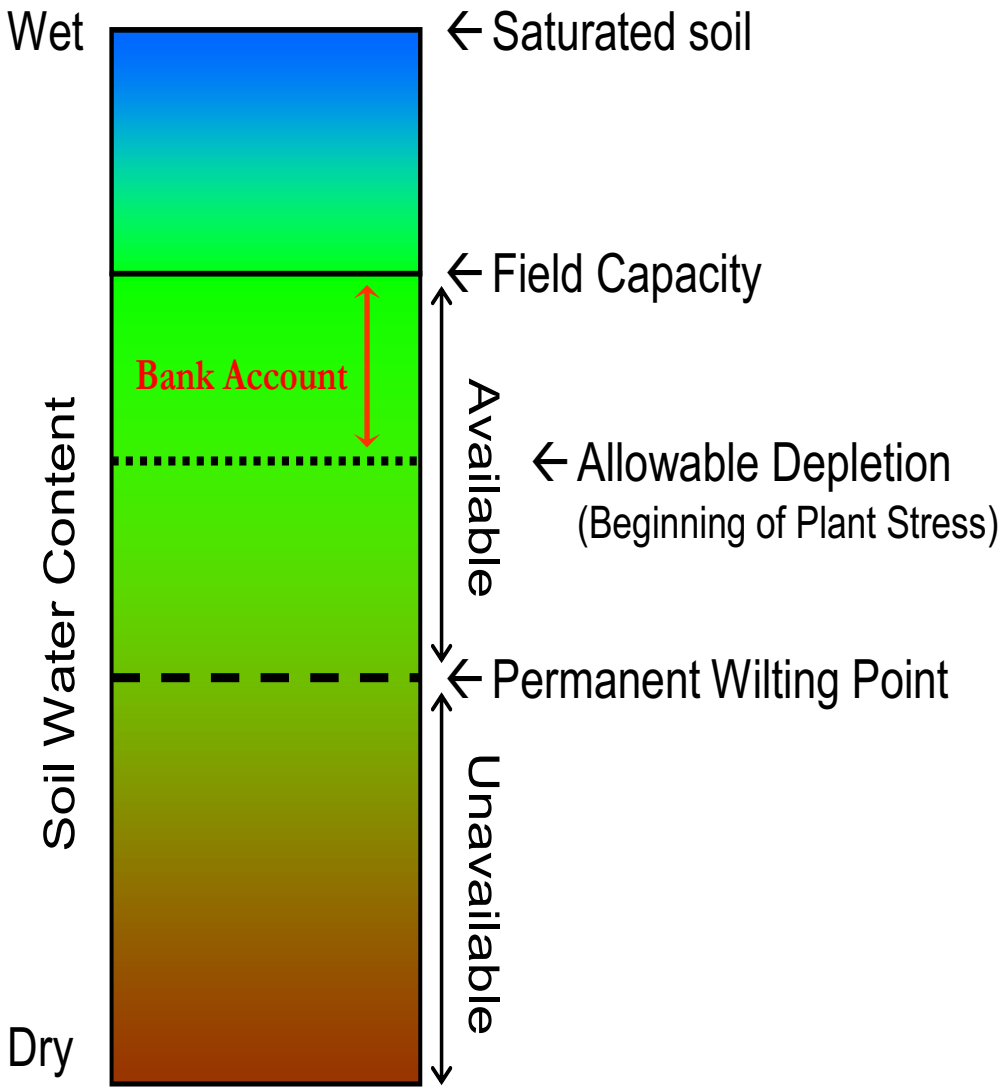


Soil-Water-Plant Relationships

Classes and Availability of Soil Water



WP is a function of soil texture, crop, ET rate, soil salinity.



A typical soil will have about 40 percent voids (5 inches per foot at saturation)

Field Capacity – about 3.5 to 4 inches per foot.

Allowable Depletion – about 2.5 to 3 inches per foot. The bank account for shallow rooted vegetables is about 1-1.5 inches

Permanent Wilting Point – about 2” per foot (specific to soils and crops).

Soil-Water-Plant Relationships

Available Soil Water-Holding Capacity (Typical)

Soil Texture	Available Soil Water	
	inch/inch	inch/foot
Sands and fine sands	0.04 - 0.06	0.5 - 0.7
Very fine sands, loamy sand	0.07 - 0.08	0.8 - 1.0
Sandy Loam	0.1 - 0.13	1.2 - 1.6
Loam, silt loam	0.16 - 0.17	1.8 - 2.1
Silty clay loam	0.16 - 0.17	1.8 - 2.1
Clay loam, sandy clay loam	0.14 - 0.17	1.7 - 2.1

The bank account for shallow rooted vegetables is about 1 to 1.5 inches. Corn, Tomatoes, Squash, etc. can be higher.

Soil Water by Feel

Sandy clay loam,
loam, and
Silt loam soils

25-50 percent available
1.6-0.8 in./ft. depleted

50-75 percent available
1.1-0.4 in./ft. depleted

75-100 percent available
0.5-0.0 in./ft. depleted

Soil Water by Feel

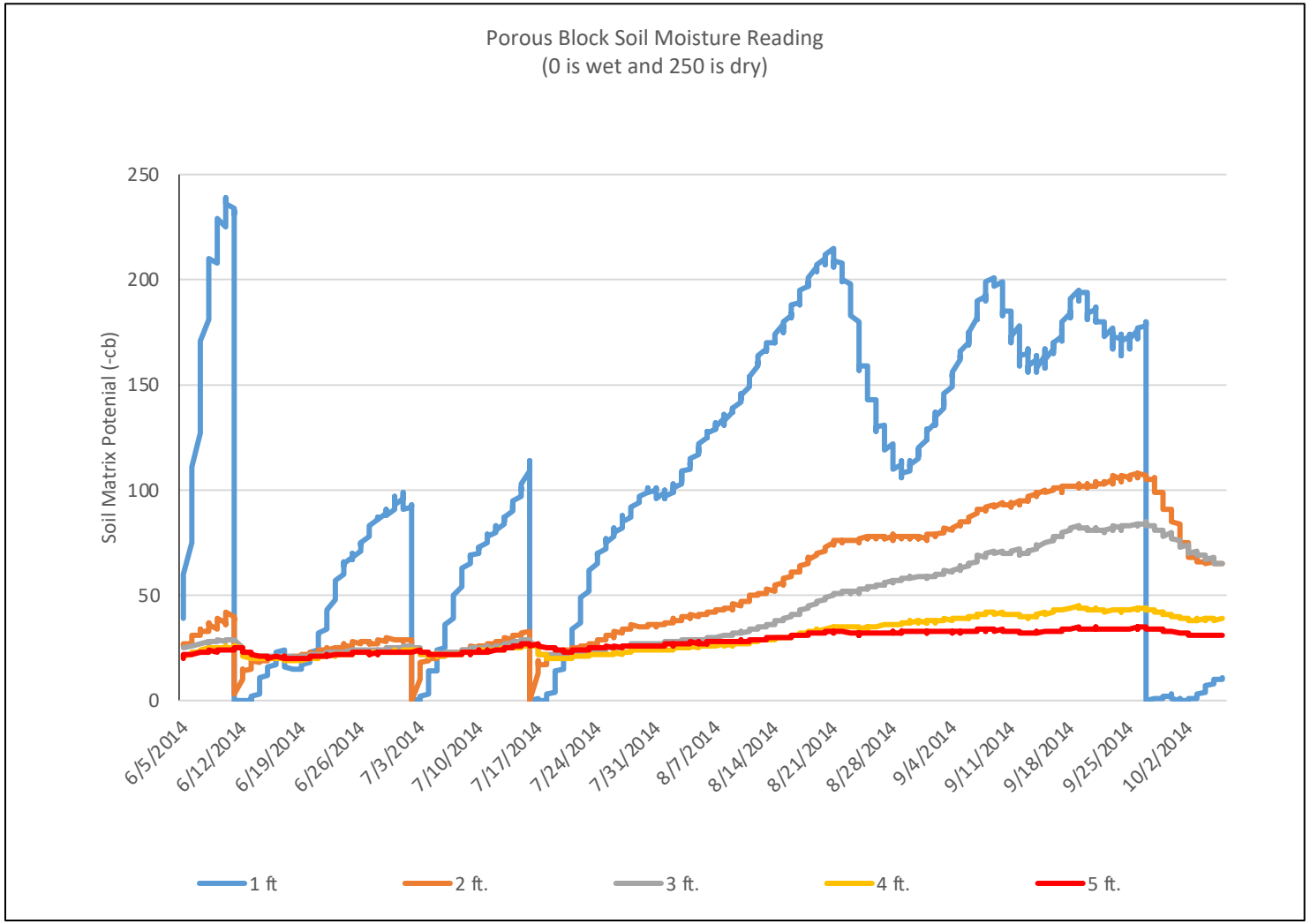
Sandy loam and
Fine sandy loam soils

25-50 percent available
1.3-0.7 in./ft. depleted

50-75 percent available
0.9-0.3 in./ft. depleted

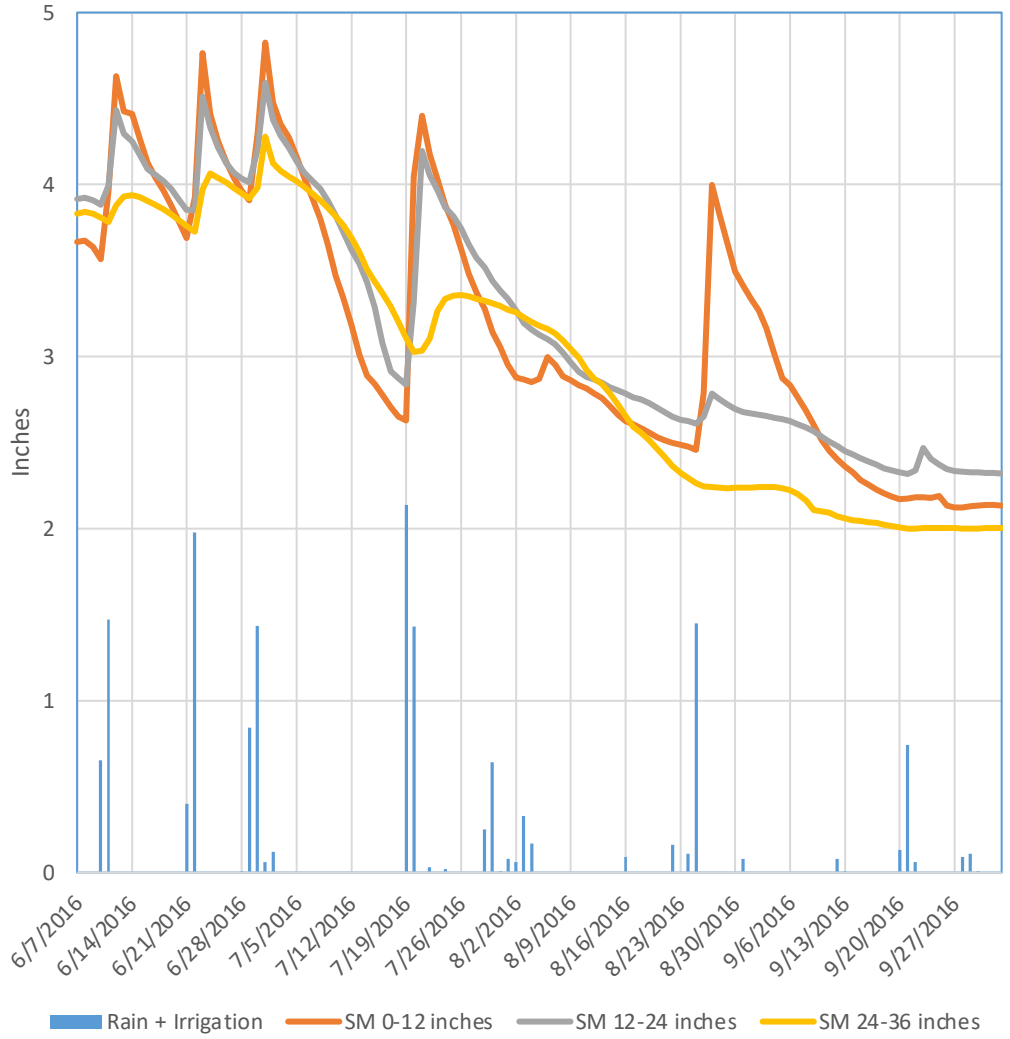
75-100 percent available
0.4-0.0 in./ft. depleted

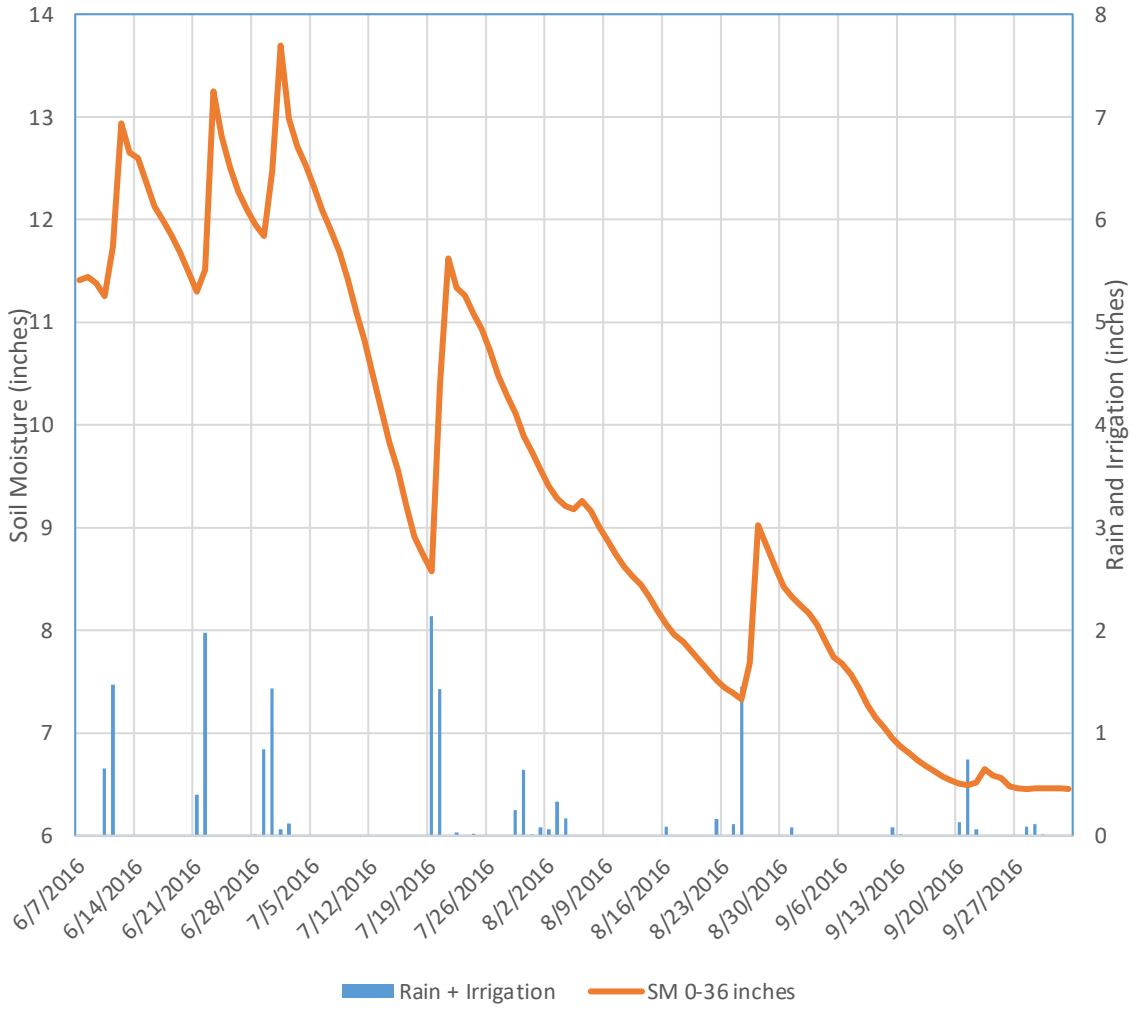

IRROMETER COMPANY
WATERMARK MONITOR
SENSORS
SENSORS


Porous Block Soil Moisture Reading
(0 is wet and 250 is dry)
Soil Matrix Potenial (-cb)
250
200
150
100
50
0
6/5/2014
6/12/2014
6/19/2014
6/26/2014
7/3/2014
7/10/2014
7/17/2014
7/24/2014
7/31/2014
8/7/2014
8/14/2014
8/21/2014
8/28/2014
9/4/2014
9/11/2014
9/18/2014
9/25/2014
10/2/2014
1 ft
2 ft.
3 ft.
4 ft.
5 ft.

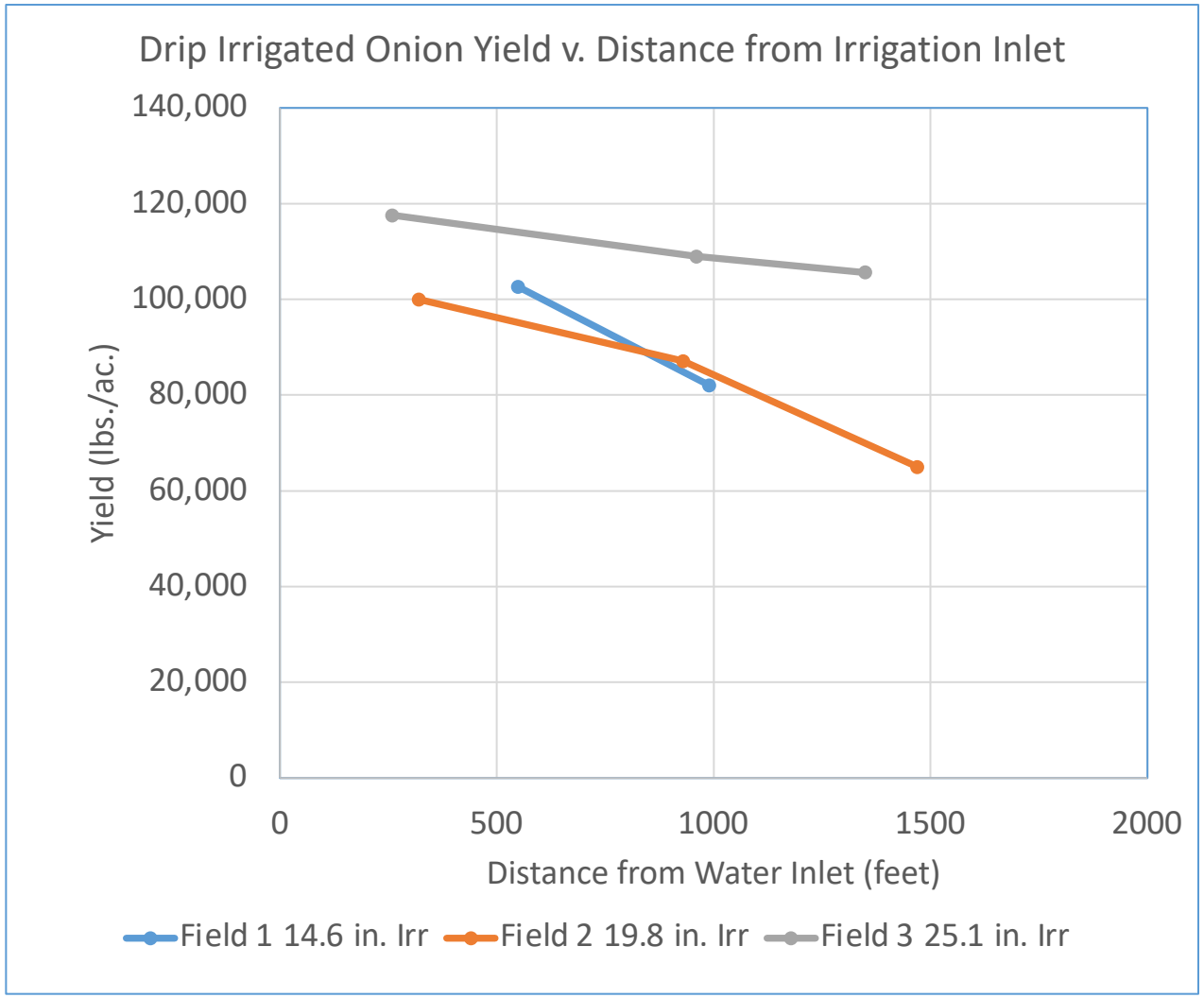
Soil Water Budget Examples for Deficit Irrigation Research (no Water Table)

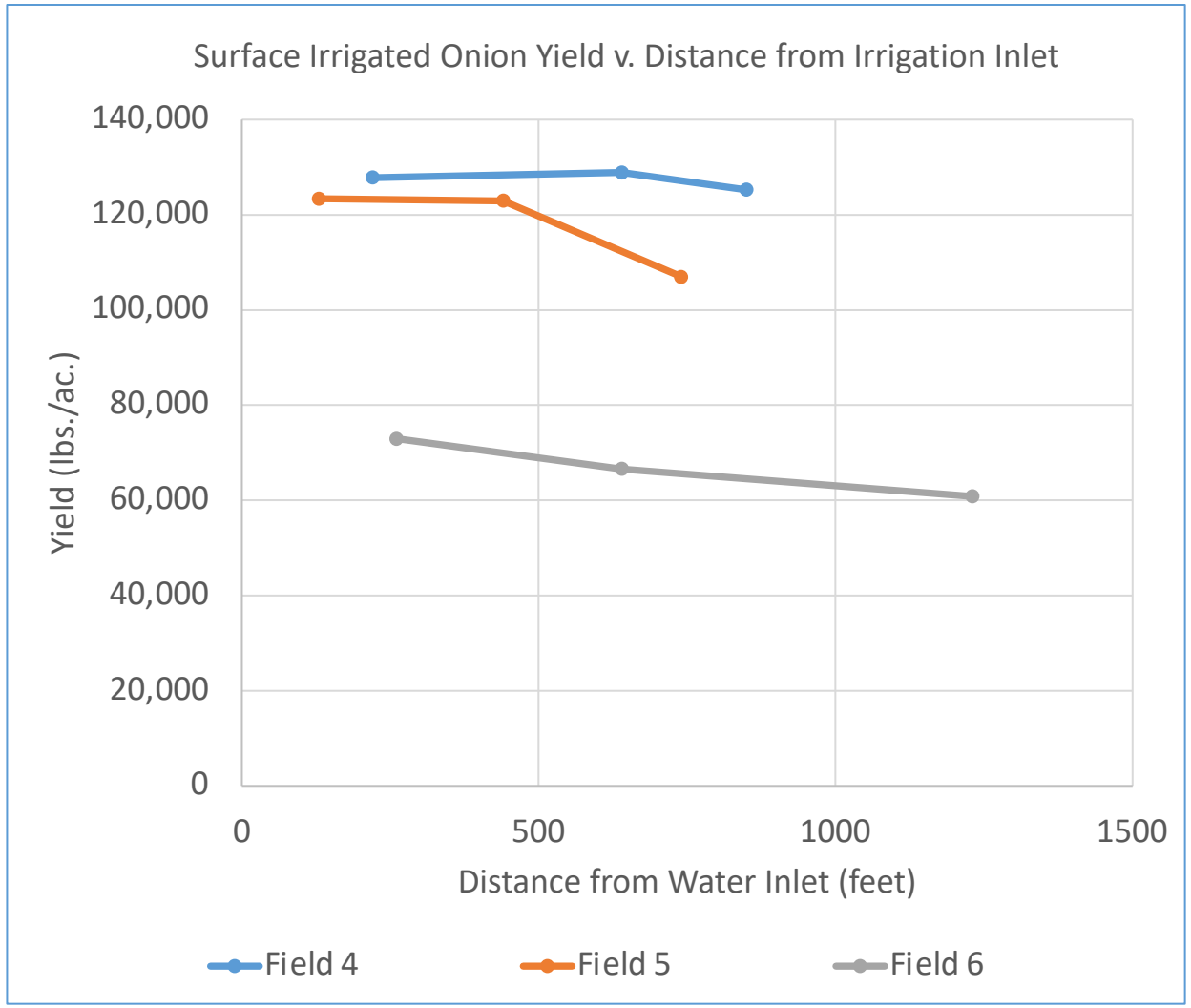
Daily Average Soil Moisture Panguitch Pasture - Irrigation Level 3 Location SM2 from Acclima TDR 315L Sensors



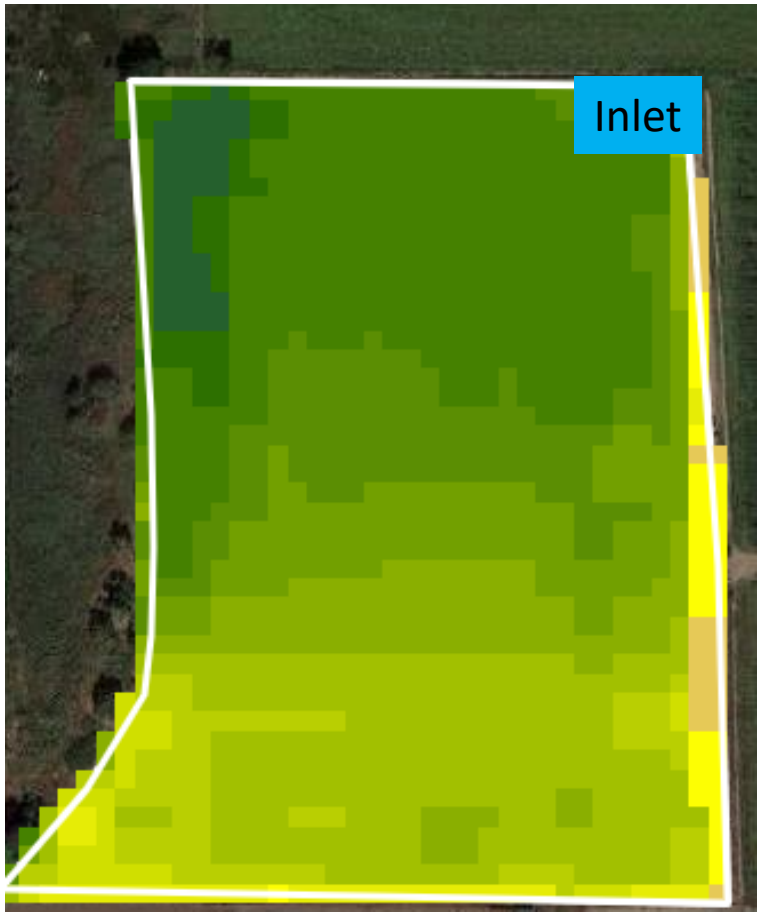


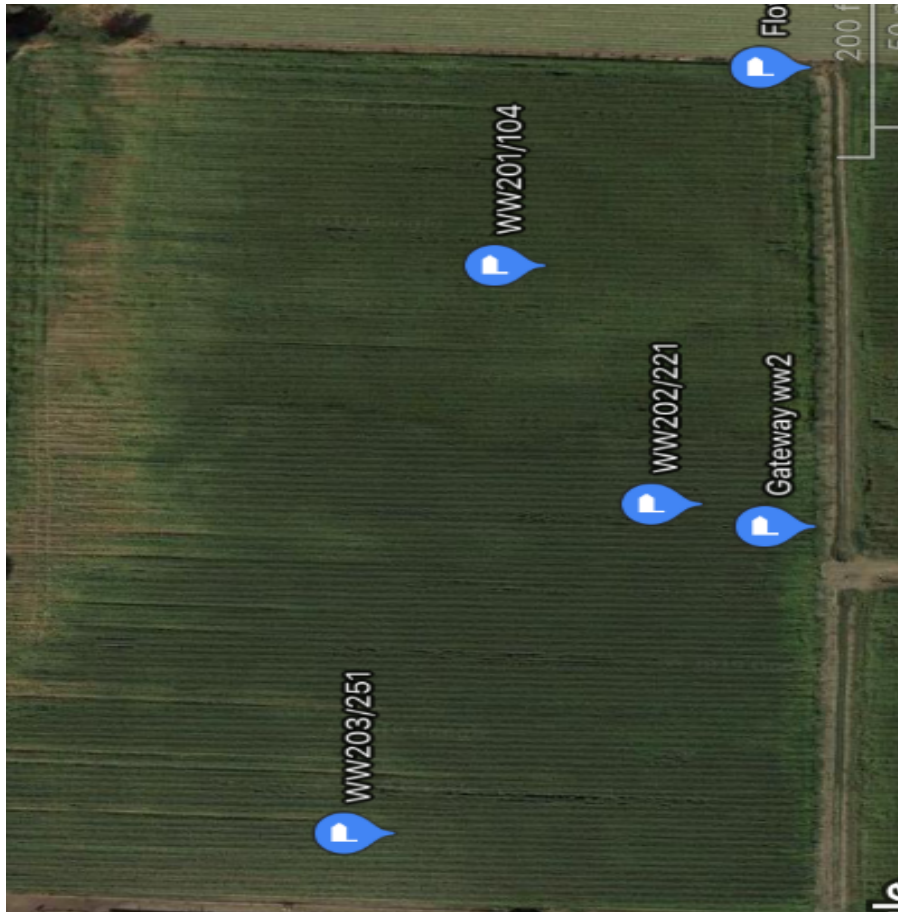
Onion Yield v. Distance from Inlet





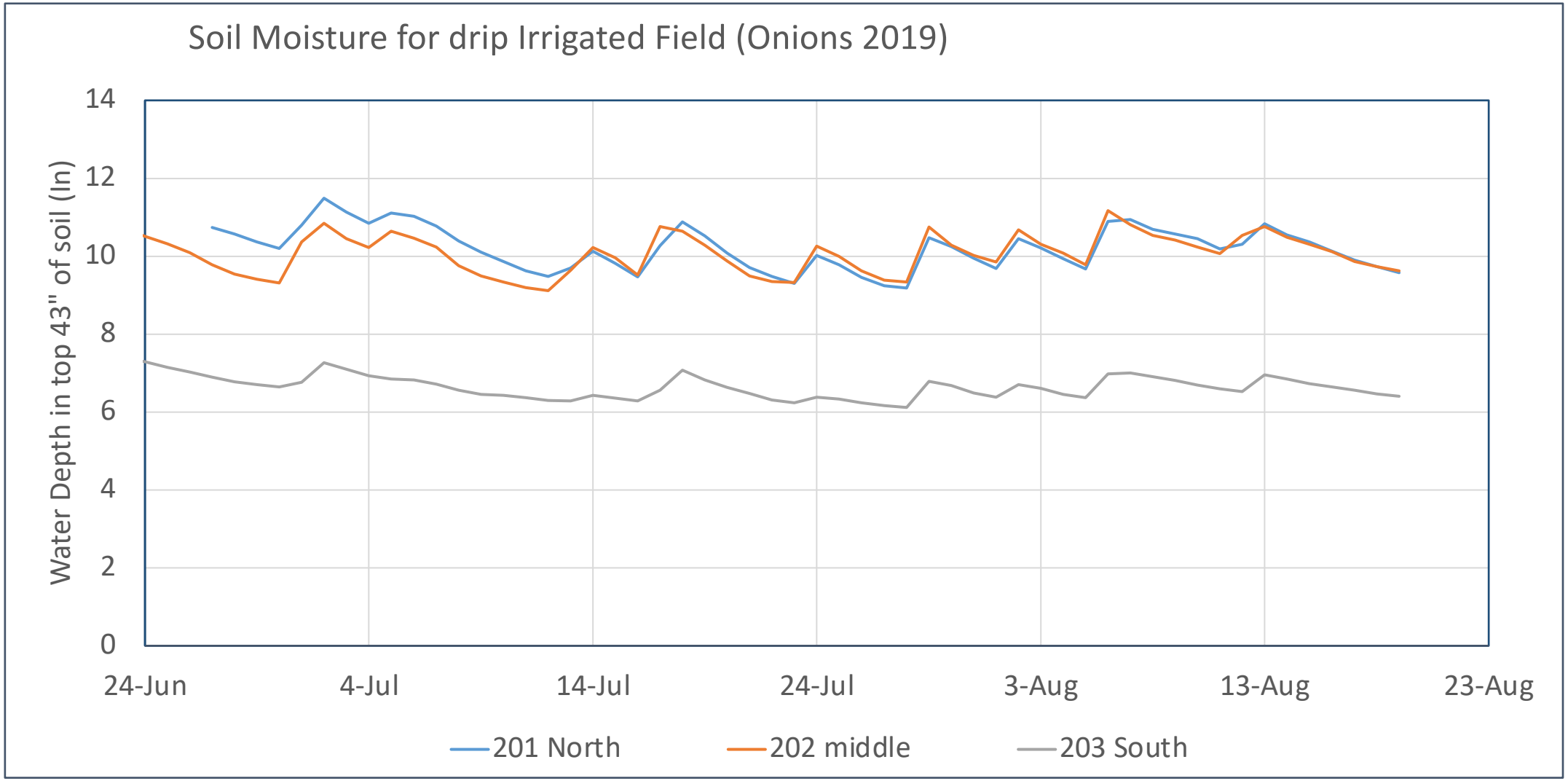
NDVI from Sentinel 2 satellite using OneSoil application





Drip Irrigated Field NDVI, August 9, 2019

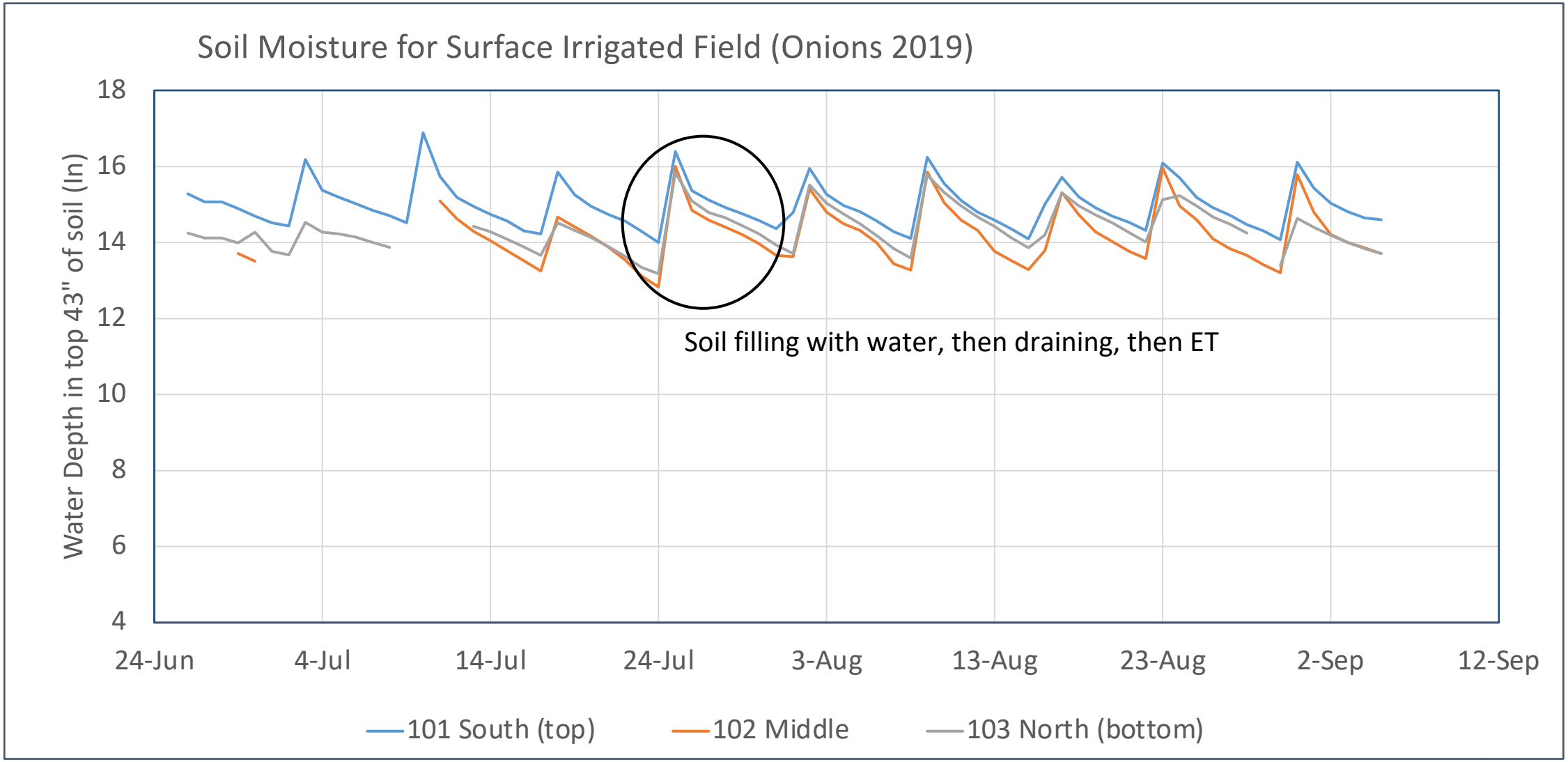
Average Daily Soil Moisture for Drip Irrigation



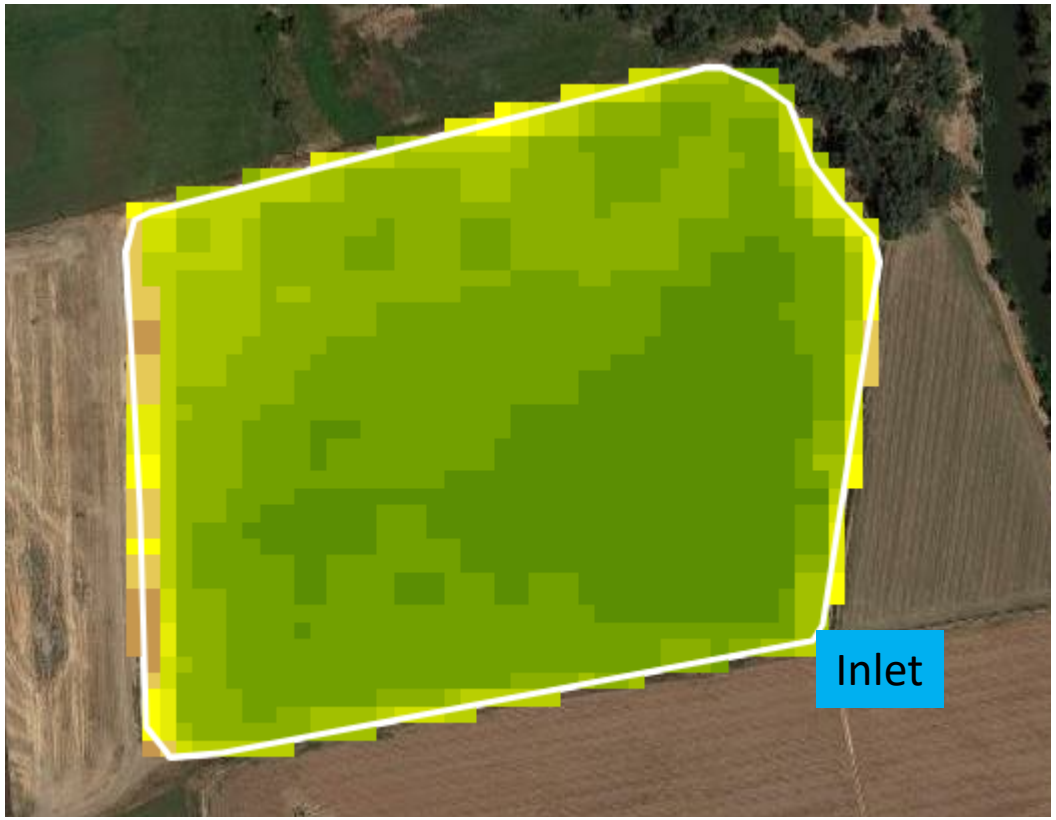
NDVI from Sentinel 2 satellite using OneSoil application

Surface Irrigated Field NDVI August 13, 2019

Average Daily Soil Moisture for Surface Irrigation

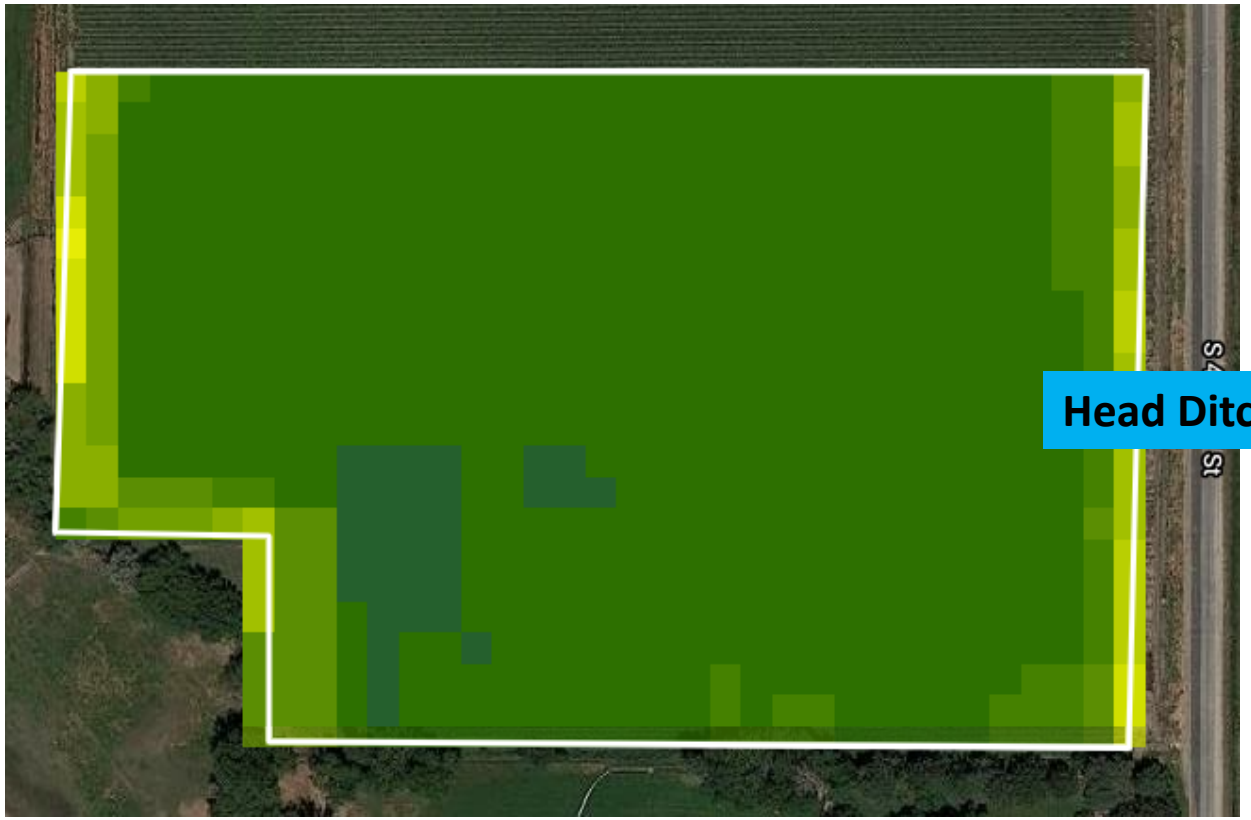


NDVI from Sentinel 2 satellite using OneSoil application

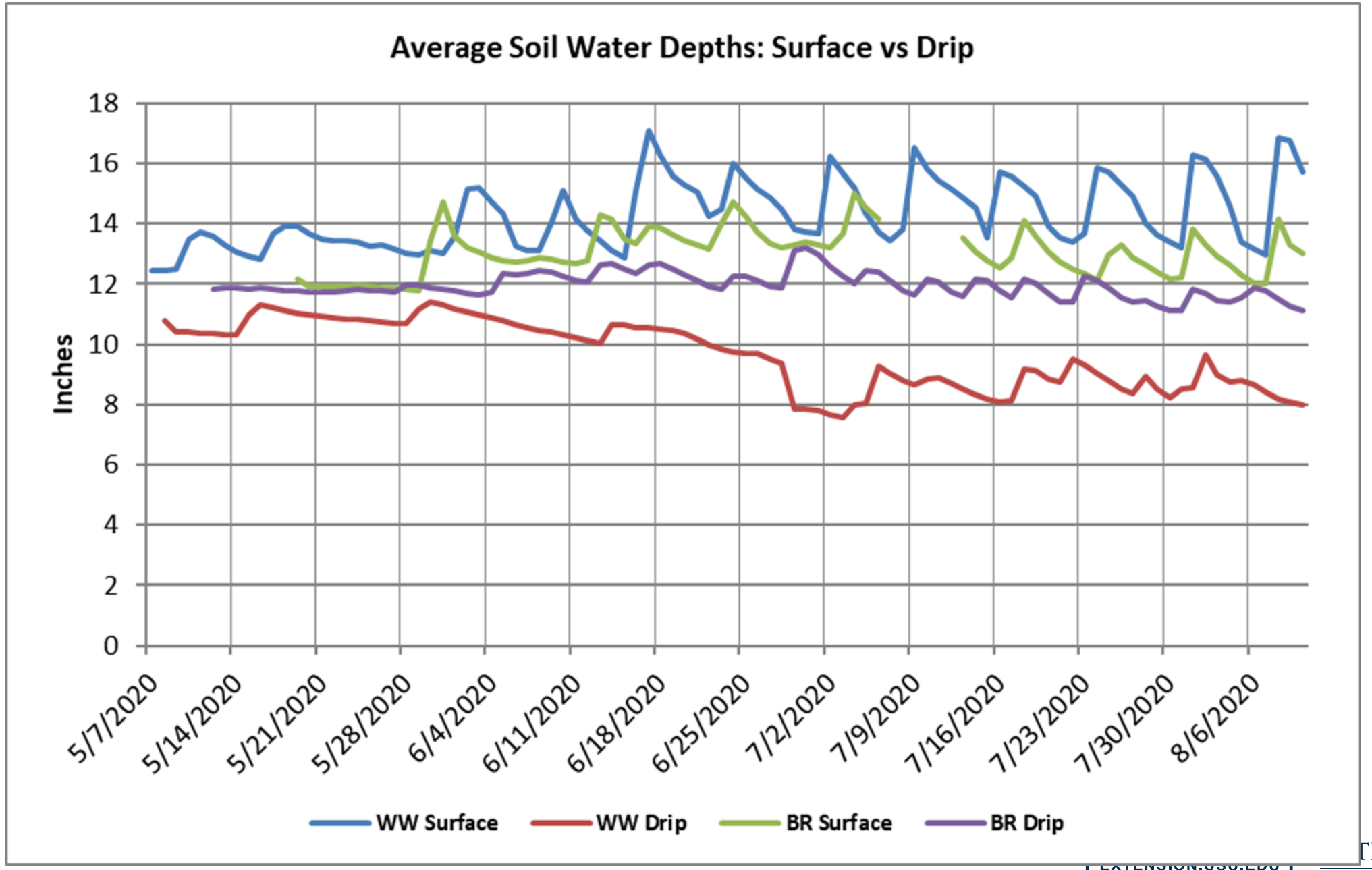


Drip Irrigated Field NDVI, August 13, 2020

NDVI from Sentinel 2 satellite using OneSoil application

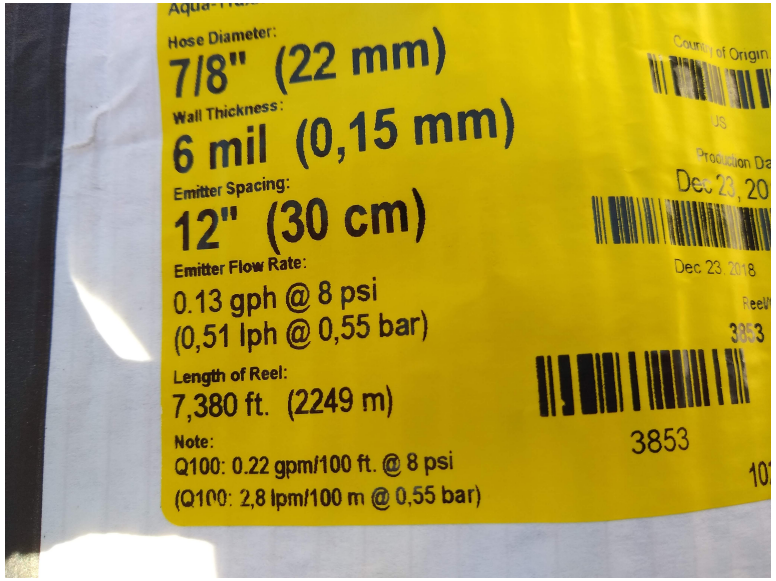


Surface Irrigated Field NDVI August 13, 2020


Average Soil Water Depths: Surface vs Drip
Inches
18
16
14
12
10
8
6
4
2
0
5/7/2020
5/14/2020
5/21/2020
5/28/2020
6/4/2020
6/11/2020
6/18/2020
6/25/2020
7/2/2020
7/9/2020
7/16/2020
7/23/2020
7/30/2020
8/6/2020
WW Surface
WW Drip
BR Surface
BR Drip

Pressure is important to irrigation Uniformity

Part Number	Spacing		gph		Exponent	Requirement
	in	cm	@ 8 psi	@ 10 psi		mesh (micron)
0.13 gph emitter						
EAXxx0467	4	10	0.13	0.15	0.5	120 (125)
EAXxx0644	6	15	0.13	0.15		
EAXxx0834	8	20	0.13	0.15		
EAXxx1222	12	30	0.13	0.15		
EAXxx1617	16	40	0.13	0.15		
EAXxx1814	18	45	0.13	0.15		
EAXxx2411	24	60	0.13	0.15		



Drip Emitter Flow Rate v. Pressure

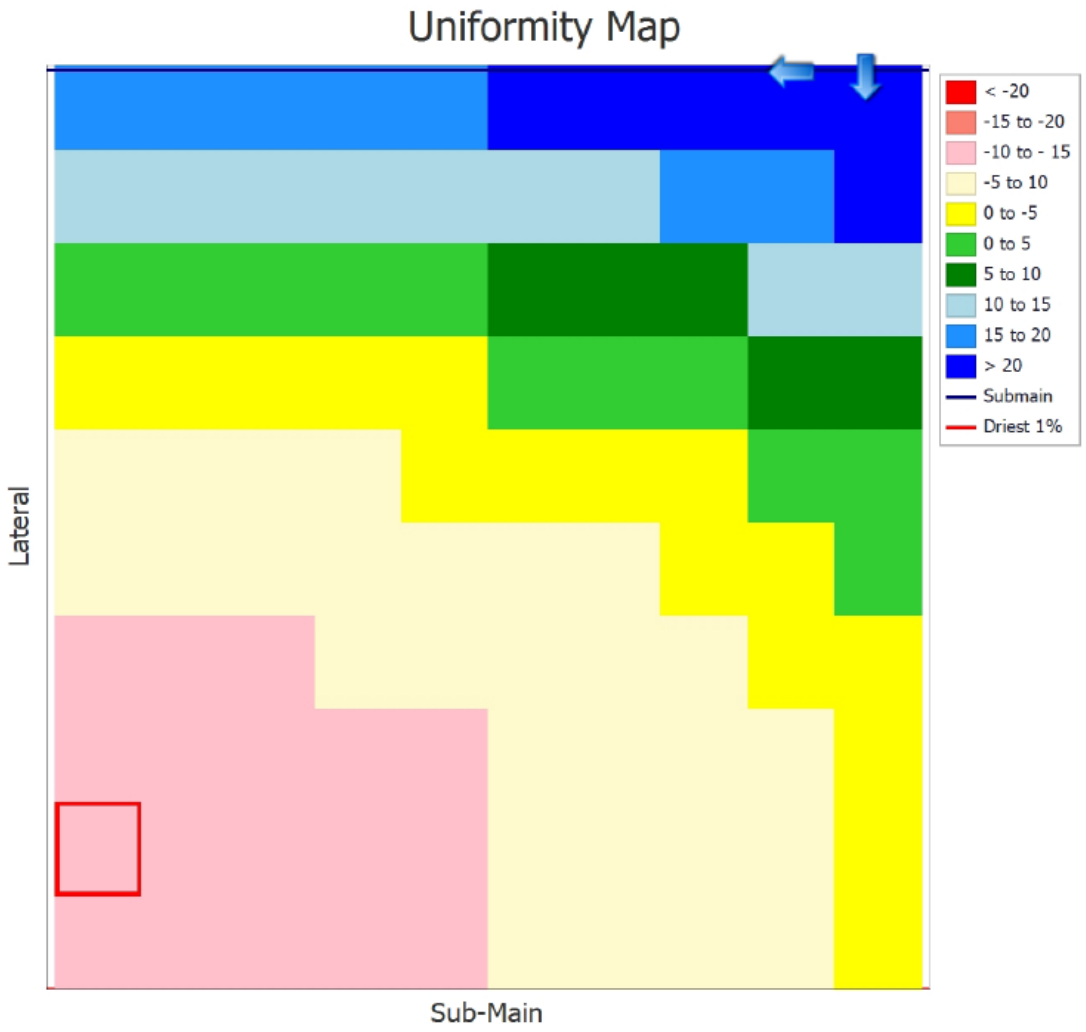
	Pressure (psi)	discharge (gph)	% of 8 psi discharge	% change from 8 psi discharge
-2 psi	6	0.113	87%	-13%
-1 psi	7	0.122	94%	-6%
Label	**8**	**0.130**	**100%**	**0%**
+1 psi	9	0.138	106%	6%
+2 psi	10	0.145	112%	12%
Range	**4**	**0.033**	**25%**	**25%**

For Comparison Sprinkler Flow Rate v. Pressure

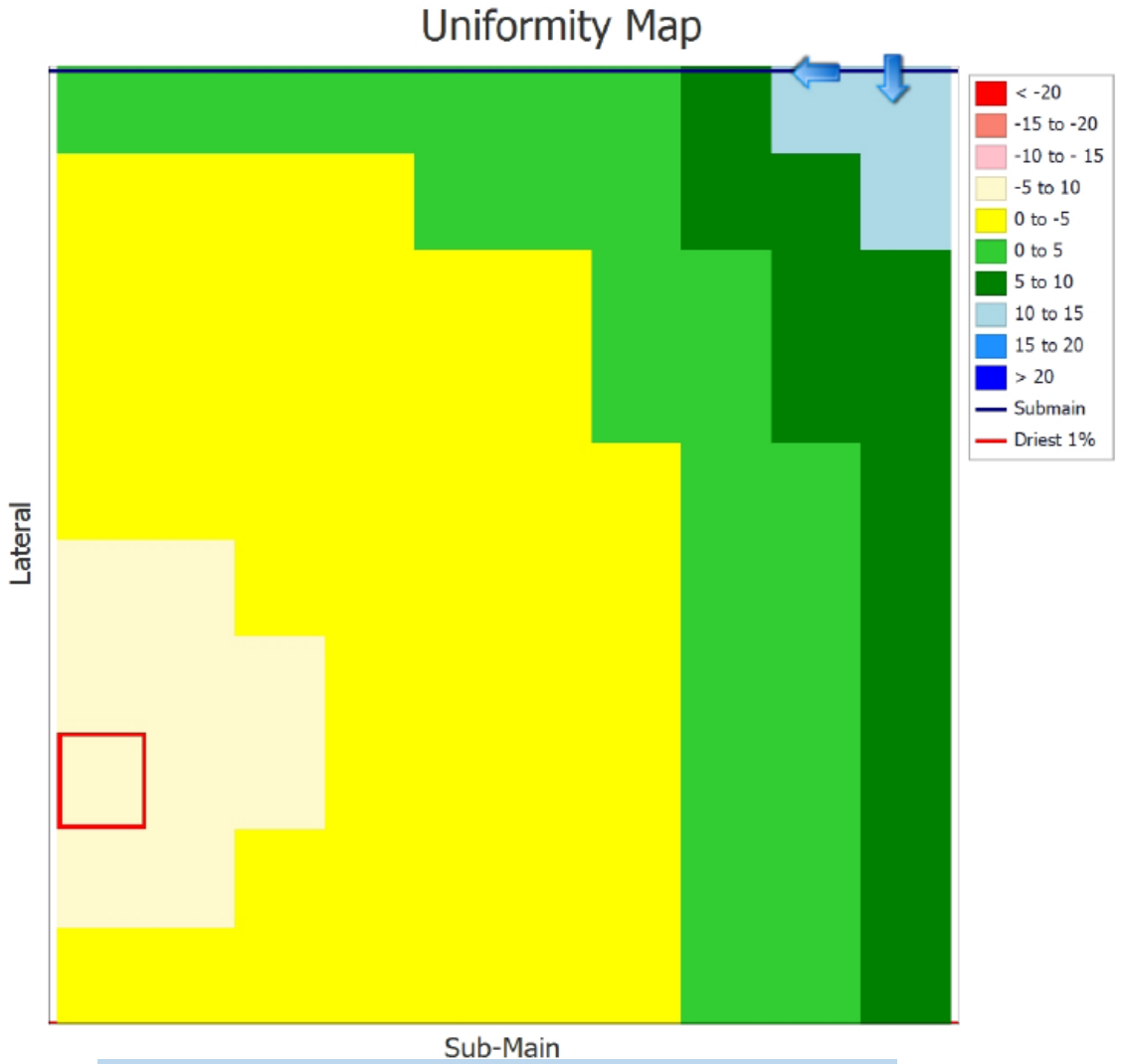
	Pressure (psi)	discharge (gph)	% of 50 psi discharge	% change from 50 psi discharge
-2 psi	48	6.859	98%	-2%
-1 psi	49	6.930	99%	-1%
Base	50	7.000	100%	0%
+1 psi	51	7.070	101%	1%
+2 psi	52	7.139	102%	2%
Range	**4**	**0.280**	**4%**	**4%**

1 psi = 2.31 feet

Drip Designs I checked were good. No design is perfect.

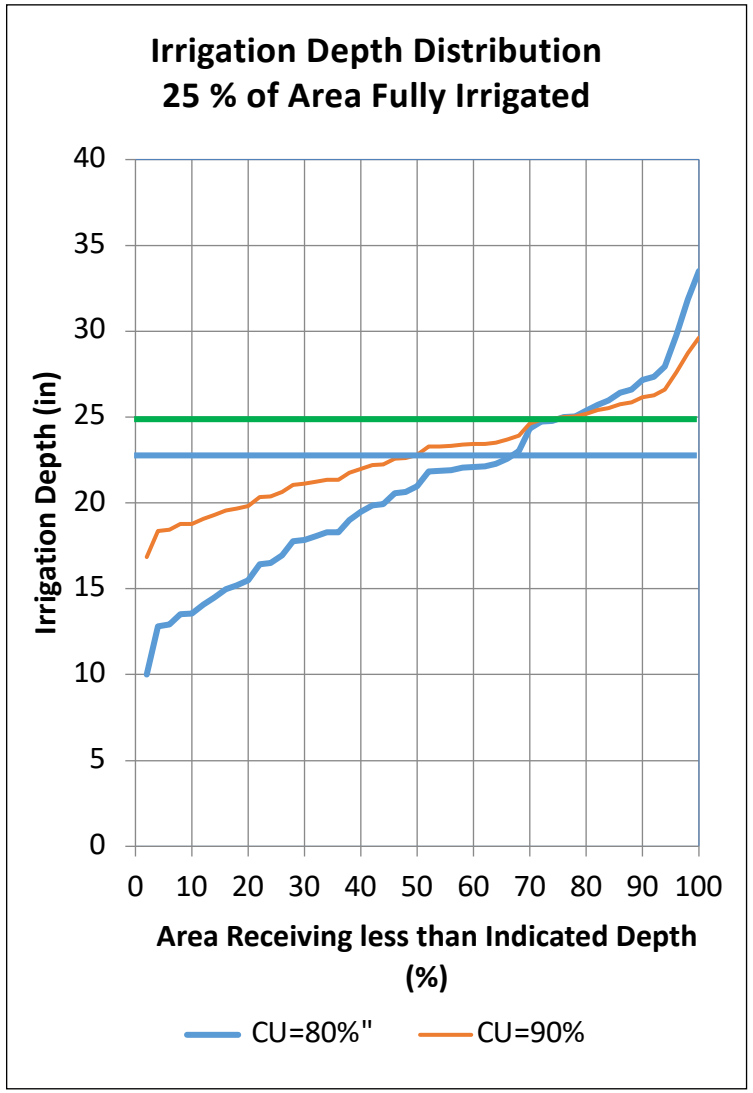


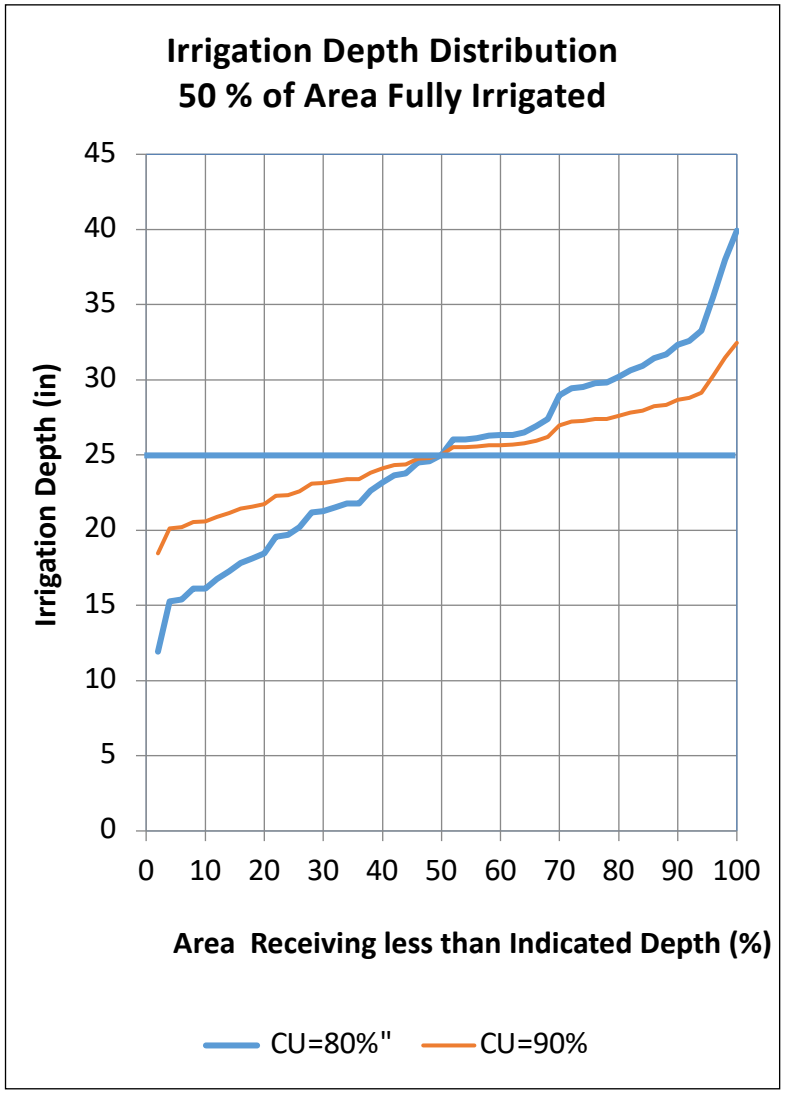
5/8” tape Emission Uniformity of 85%

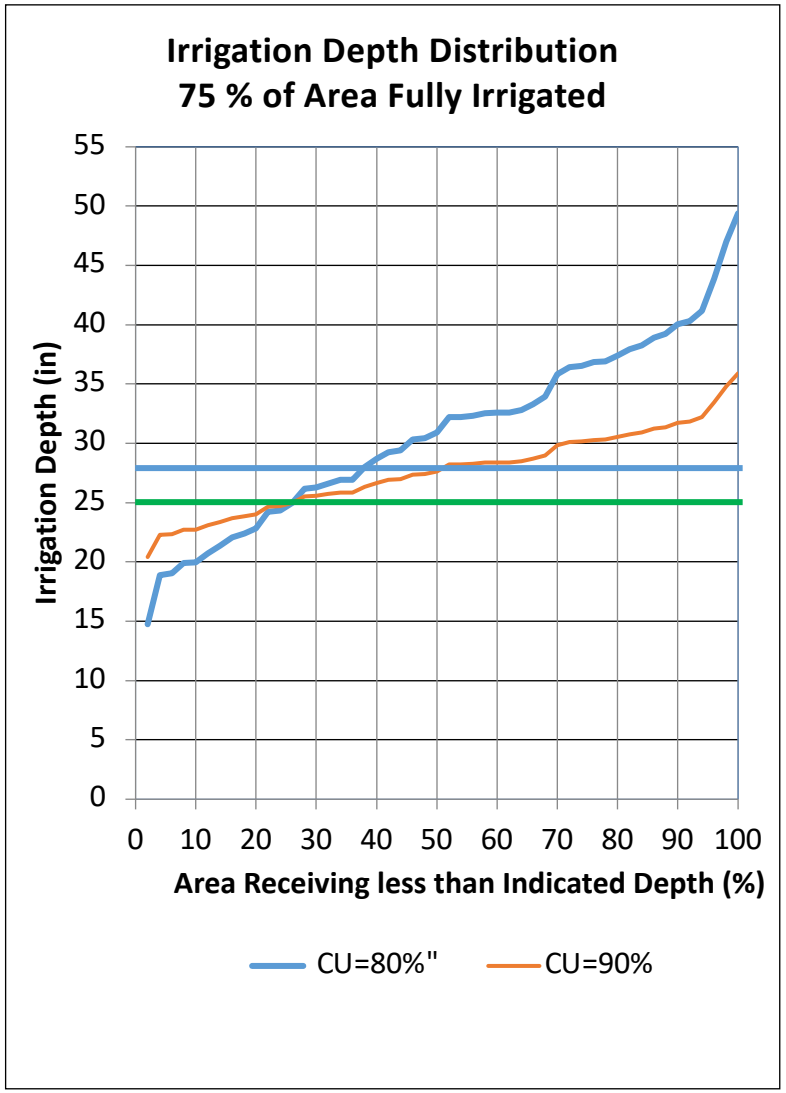


7/8” tape Emission Uniformity of 91%

Irrigation and Yield

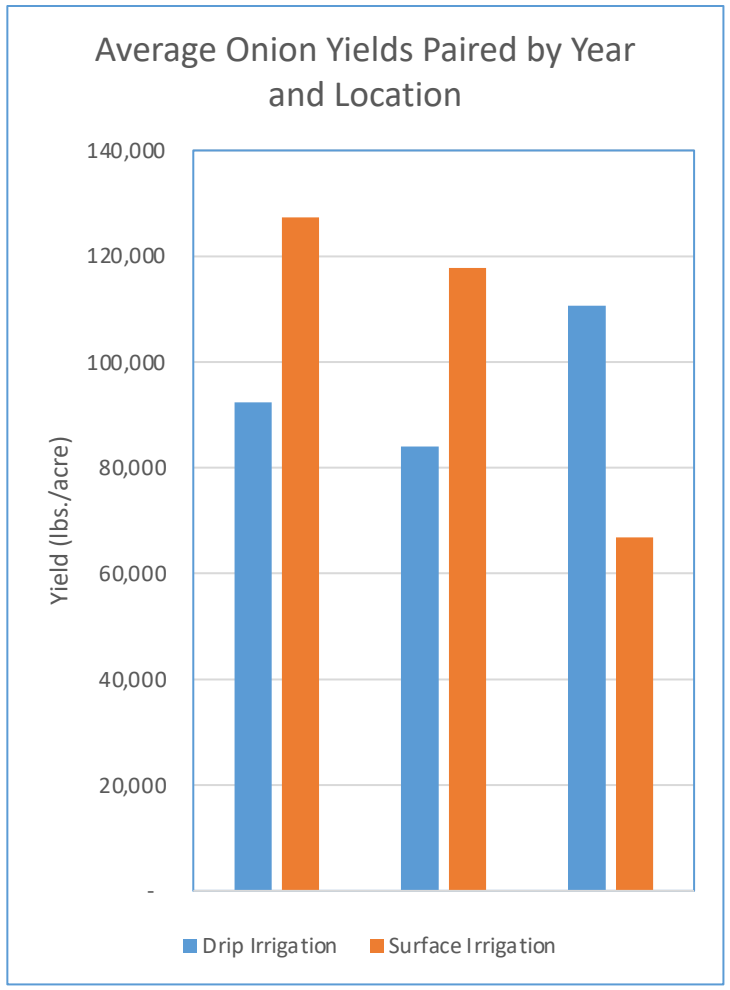


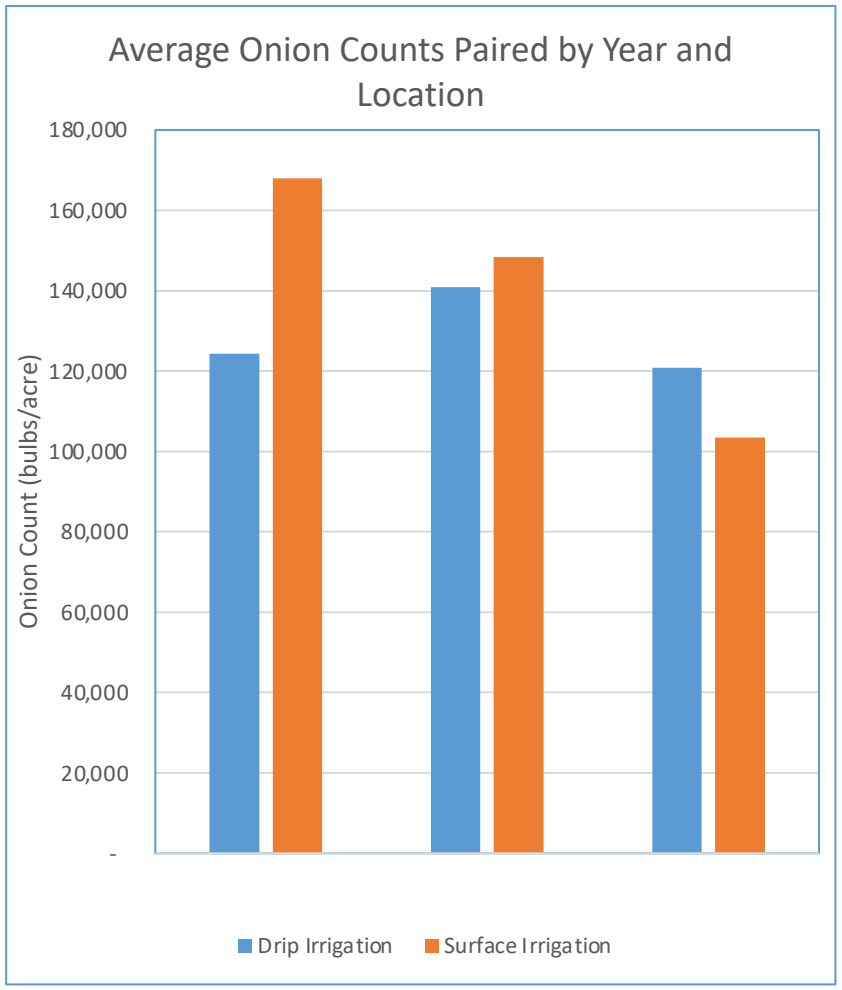


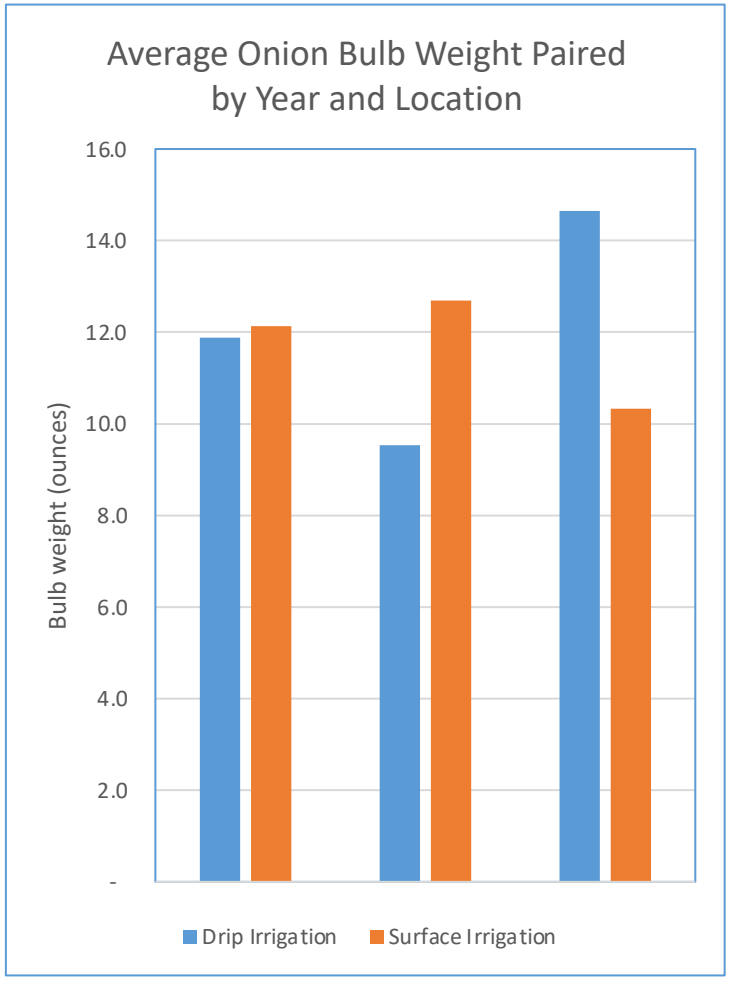


Yield sampling of onions

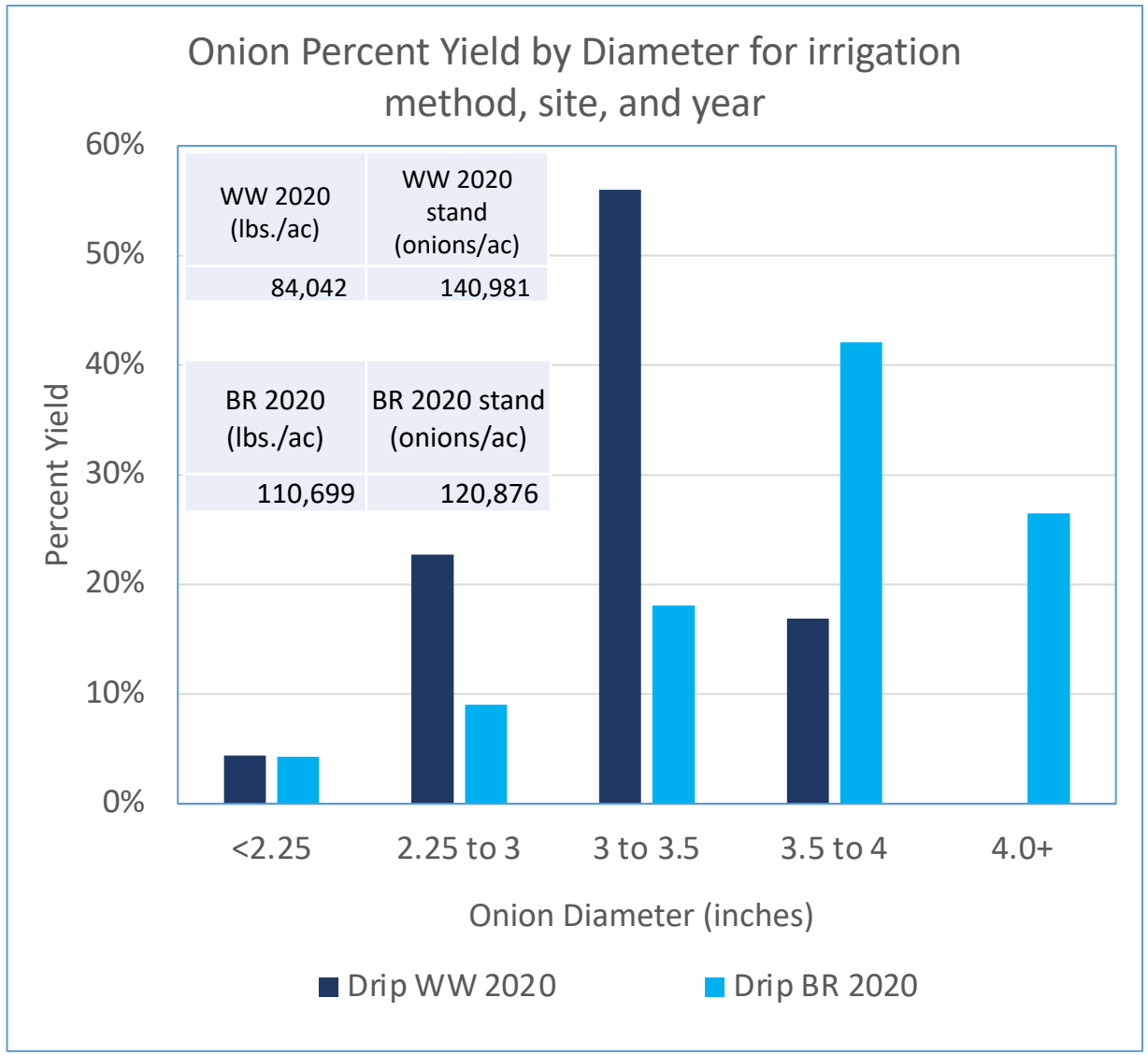
Onion Yield, Count, and Size by Field

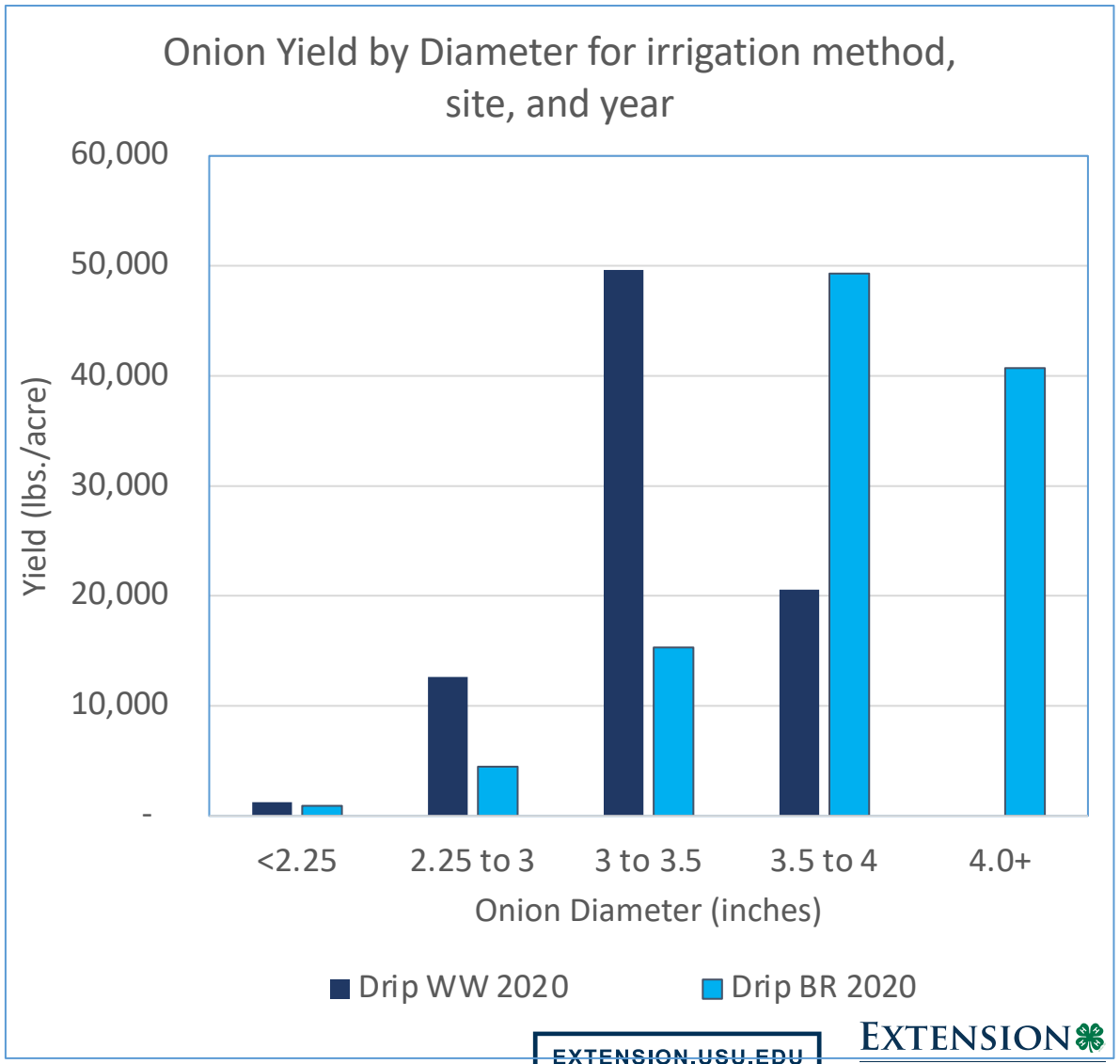




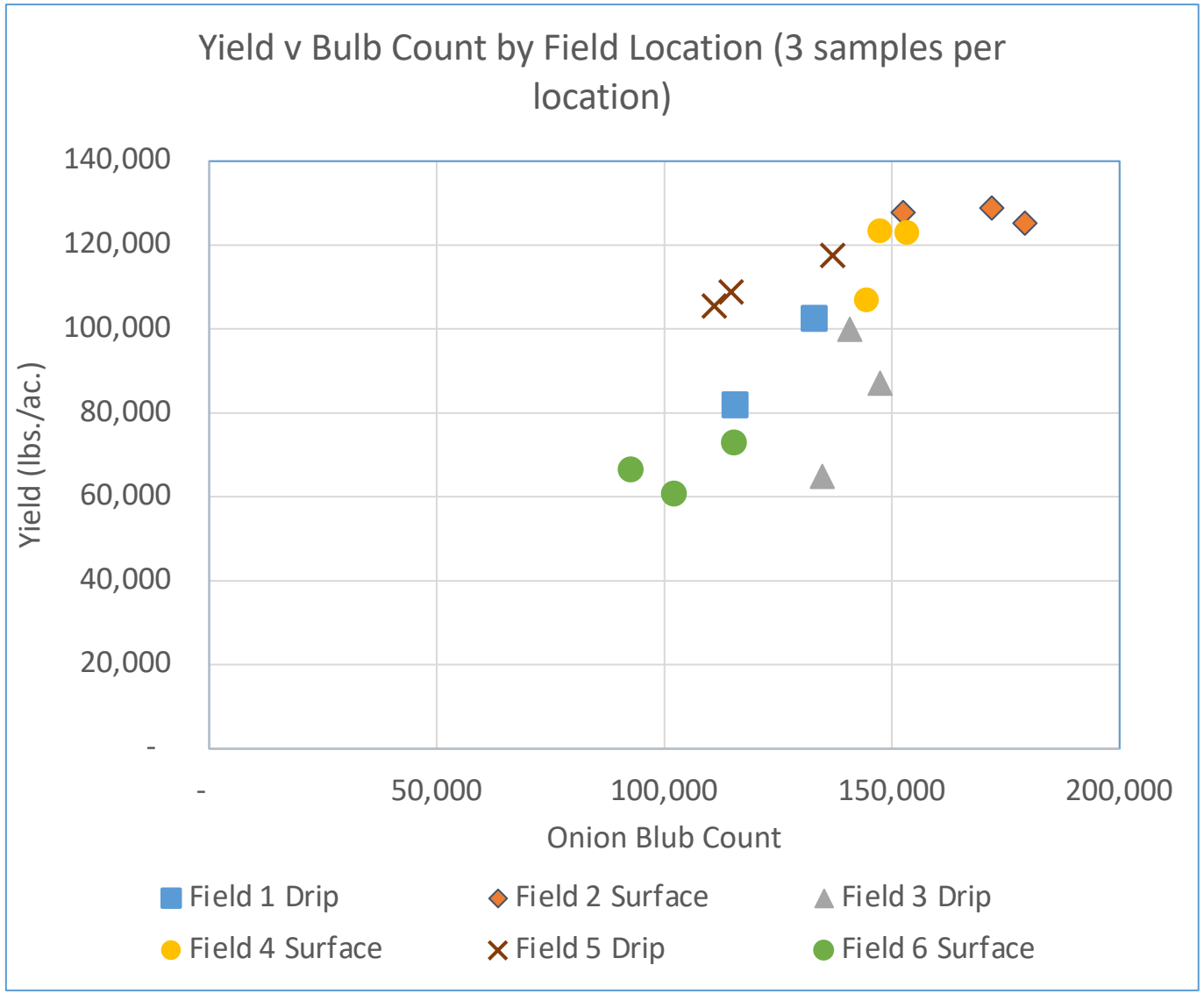


Onion size yield and count by field for two irrigation levels





Onion Count and Yield



- **Fields 1 and 2** are 2019 fields– Different varieties, planted and harvested on different dates.
- **Fields 3, 4, 5 and 6** are 2020 fields – The were all same variety (Hamilton), planted the same week, and harvested about the same time.
- **Fields 2 and 4** where established with drip irrigation and surface irrigated.

My ideas for your consideration (based on limited observation)

- Onion establishment and high population are needed for good yield.
  - Drip irrigation helps provide good establishment
- Surface irrigators do a good job of applying adequate water through high application per irrigation
  - No observed yield reduction from over-irrigation in the surface irrigated fields.
- It is easy to under-irrigate with a drip irrigation system.
- Drip irrigation uniformity, while good can result in under irrigation of some or most of the field.
  - Monitor your crop in a low water delivery location
  - Carefully design your drip irrigation system
  - Remember your fertilizer application through the irrigation system is applied the same as the water.

My ideas for your consideration (based on limited observation)

- Apply about 25 inches or more with a drip system during a dry summer.
  - Surface irrigators are applying 2 to 3 times more water
- For drip irrigation using 0.13 gph emitters at 12-inch spacing irrigate about 16 hours twice each week during June-August (about 2 inches per week).
  - Monitor your field a locations that receive less water average.
  - Use OneSoil Application to check vegetation uniformity.
- The fuel/energy to fully-irrigate with a drip system is only pennies on the dollar compared to under-irrigation.
  - Yield difference 20,000 to over 30,000 lbs./acre in the same field based on irrigation application differences.

Other Consideration

- Some periods are more critical than others
  - For high yield reproductive through harvest for fresh vegetables and fruit
  - Some stress may be used for quality rather than yield (grapes as an example)
- High fertility = large plants = high water use
- Keep soil moisture high to compensate for high salinity
- Soil moisture and fertility can impact flowering v. vegetation.

Questions