Irrigation system evaluation Report #3

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Dates: 9/2, 9/16, 9/17, 9/23, 10/1, 10/13, 10/18/2021; **Nursery**: Altman Plants, 2575 Olive Hill Rd, Fallbrook

Contacts: Carlos Camacho (Nursery Manager); Javier Lopez (Head Grower), Edgar (Irrigation Specialist)

Read only this page if you do not have time! The following pages explain each recommendation

1- The pressure at the field A30 is highly variable and the irrigators do not have control over it. This is one the main issues to be addressed. Pressure gauges or Schrader valves can be installed at each block valve to measure pressure. When the pressure is too high, the irrigator needs to adjust it down by throttling the block valve. Alternatively, pressure regulators can be installed at each block valve. When the pressure is too low, the irrigator needs to call Pedro to turn on the booster pumps. If the pressure is still too low, the irrigator should not irrigate. Another way to improve pressure is to repair the VFD controller at the pond pumps. The VFD will keep the pressure constant regardless of how many blocks are being irrigated (within the pump power capacity).

2- The comparison of performance of Hunter PGP Ultra and Senninger Wobbler sprinkler heads showed generally a better distribution uniformity for the Wobblers, particularly at high wind speeds (6 to 9 mph). Another advantage of the wobblers is that they perform always better than the Hunter PGP at low pressures (20 psi) although the DU can be relatively poor (DU = 0.58 to 0.70). Irrigating in the morning or at night is recommended to avoid high wind speeds.

3- Irrigation scheduling at the monitored block (Valves 20 and 21, Field A30) for the period Mid-September to end of October followed closely reference evapotranspiration from the CIMIS weather station in Escondido. Thus, low runoff is expected to discharge from the block, despite the poor distribution uniformity. I recommend working on other blocks where high runoff is generated. Also, measurements of container weight indicated that the containers never reached a weight above container capacity, so little or no leachate is expected. This could be a problem on longer cycle crops, since typically a 10%-20% leaching fraction is recommended to avoid salt build up in the pots. Irrigators and growers would greatly benefit from routinely weighing containers to drive irrigation scheduling decisions.

4- A water sample from the retention pond gave low nitrate concentration (42 ppm of NO_3^- or 9.5 ppm of NO_3^--N), high pH (7.85) and very high salinity (EC = 2 dS/m). I recommend blending the pond water with fresh water to achieve a lower EC before using it for irrigation. There used to be an automatic blending system at the pond that could be repaired. We did not find Phytophthora in the water despite baiting for it.

5- Generally, better maintenance could be provided the irrigation system. For example, a leak from the filters at the injector station has caused the injector filter area to flood for months.

Recommendation 1: The pressure at the irrigation blocks is variable

The pressure at the field A30 is very variable (Figure 1). This is because irrigators have the freedom to turn on irrigation valves as they please. Pressures during distribution uniformity measurements ranged from 19 to 38 psi at valve 20 and from 32 to 71 psi at valve 21 (Figure 6). I recommend making an irrigation schedule that all irrigators need to follow.

Pumps produce high pressures at low flowrates and low pressures at high flowrates. The total flowrate is roughly determined by how many sprinkler heads are being used to irrigate, or how many blocks are irrigated at the same time. This phenomenon causes the pressure to drop when one irrigates more blocks (requiring higher flowrates from the pump) and to increase when smaller areas are irrigated. This is the cause of the highly variable pressure experienced at the irrigation block. The Hunter PGP Ultra require about 40 psi of pressure. High pressures can be addressed by installing pressure regulators at each block. Low pressures can be addressed by turning on the booster pumps, but these have a limited capacity, so there is only so much area that can be irrigated at once without dropping pressure below 40 psi. If the pressure is too low, one irrigation block needs to be turned off to avoid dropping the pressure for other blocks being irrigated at the same time. To avoid this conflict, other nurseries have adopted a timeslot approach where each irrigator is allowed to use the water only during a specific time window, e.g. from 8:00 am to 11:00 am.

At the pumping station near the retention pond there is a VFD, that is a device that allows pump to maintain a constant pressure regardless of the flowrate that is required. In other words, one has the flexibility to irrigate at the same time more or less blocks and the VFD will maintain the pressure constant. However, there is still an upper limit on how much area can be irrigated at once and this is determined by the pump power. Pedro indicated that the VFD and the automatic blending of pond and freshwater are not working anymore. Also, it seems that the sand media filters are not operational. I suggest getting this equipment serviced to improve pressure at the irrigation blocks.

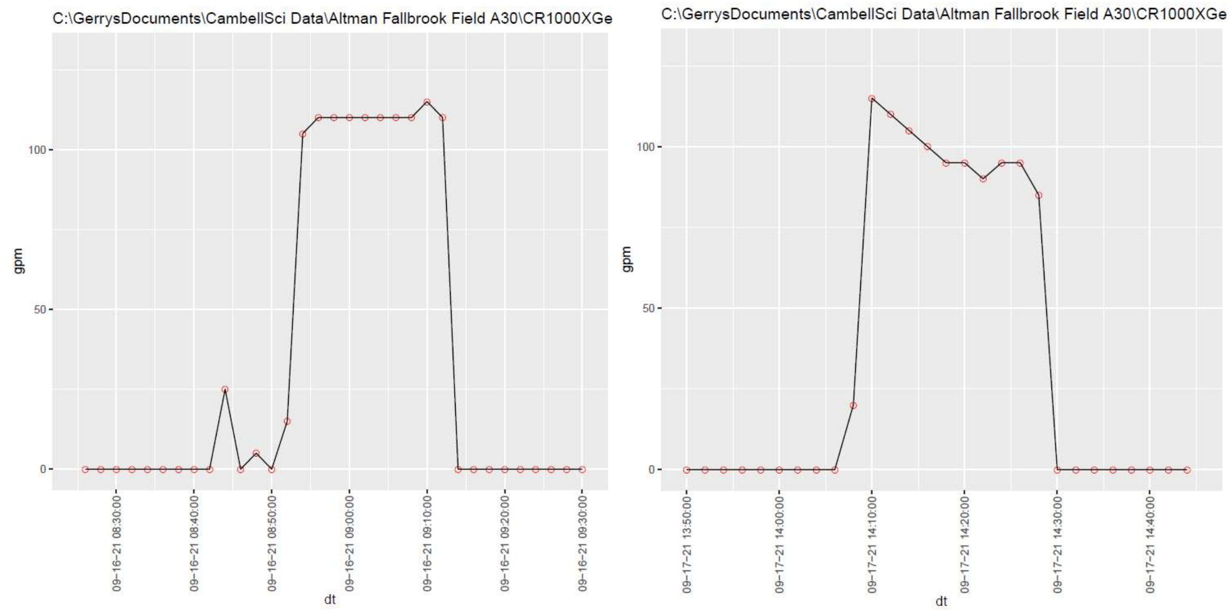


Figure 1. Examples of flowrate during irrigation events with constant pressure (left) and of irrigation event with decreasing pressure (right) recorded on 9/16 and 9/17.

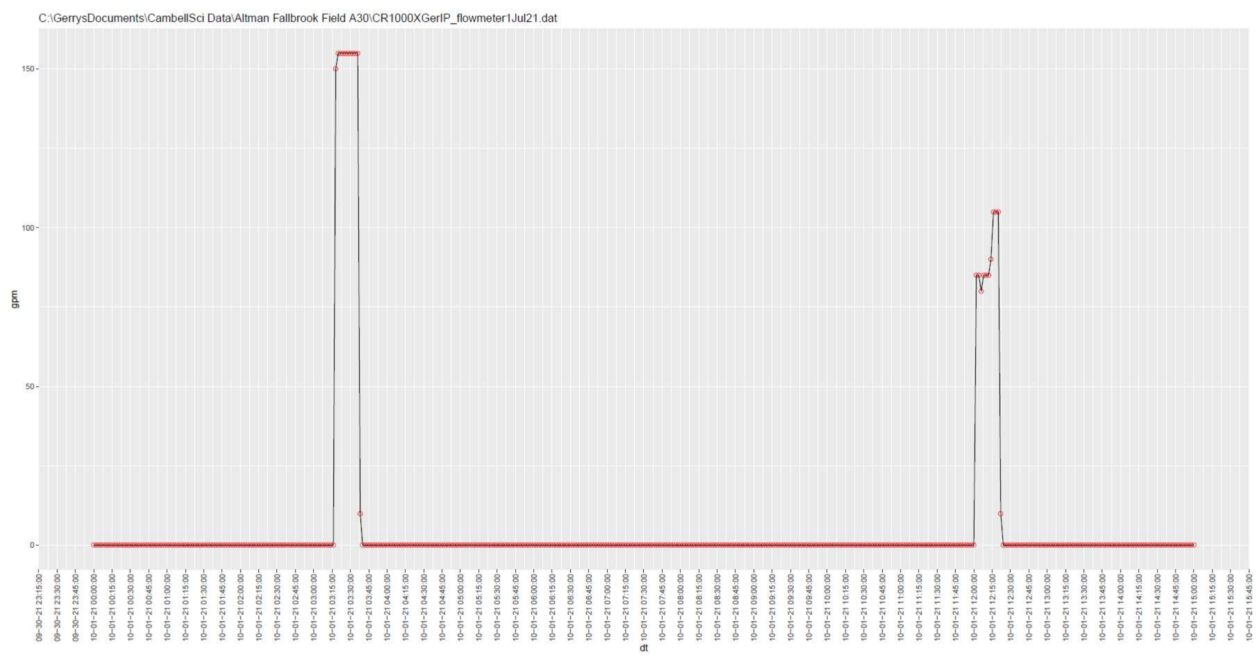


Figure 2. Example of two irrigations measured by the flowmeter at high and low pressure, resulting in high and low flowrates.

Figure 3. Example of "throttling". The pressure was 74 psi and by partially closing a valve we reduced it to 42 psi. The same result can be achieved with a pressure regulator.

Recommendation 2: Xcel Wobbler sprinklers are performing better than the Hunter PGP ultra

Nozzle	Pressure	Radius	Flow	Precip in/hr	
	PSI	ft	GPM	■	▲
4.0 ● Blue	25	37	3.0	0.42	0.49
	35	39	3.5	0.44	0.51
	45	40	4.0	0.48	0.56
	55	41	4.5	0.52	0.60
	65	41	4.8	0.55	0.63

Figure 5. Hunter PGP Ultra sprinkler head specs

XCEL-WOBBLER™

XCEL-WOBBLER DESIGN CRITERIA	psi			
	10	15	20	25
#10 Nozzle - Turquoise (5/32")				
Flow (gpm)	2.22	2.72	3.14	3.51
HA Diameter at 1.5 ft ht (ft)	44.5	49.0	50.5	53.5
MA Diameter at 1.5 ft ht (ft)	36.0	41.0	42.5	44.0

Figure 4. Senninger Xcel Wobbler sprinkler head specs

We installed Senninger Xcel Wobbler sprinkler heads at block 20, leaving the Hunter PGP Ultra at block 21 and we measured distribution uniformity three times, on 9/16, 9/17 and 9/23. Then we swapped the sprinkler heads installing the Wobblers at block 21 and the PGPs at block 20 and we measured distribution uniformity on 10/1, 10/13 and 10/18. Distribution uniformity was measured by setting up two areas of 36 buckets (a grid of 6 x 6) in each block of sprinkler heads (Figure 9). We also installed an anemometer to measure wind speed (Figure 12). The results of this study are in Figure 6.

Sprinkler head		9/16/2021				
	Field A30 Valve	DU	Pressure, psi	Application rate, in/hr	Block flow rate, gpm	Wind speed, mph
Senninger Wobblers	20	0.70	21	0.32	110	3.1
Hunter PGP Ultra	21	0.70	40	0.35	110	
		9/17/2021				
Senninger Wobblers	20	0.64	19	0.31	98	6.9
Hunter PGP Ultra	21	0.59	34	0.34	99	
		9/23/2021				
Senninger Wobblers	20	0.58	19	0.29	103	2.2
Hunter PGP Ultra	21	0.67	40	0.38	101	
		10/1/2021				
	Field A30 Valve	DU	Pressure, psi	Application rate, in/hr	Block flow rate, gpm	Wind speed, mph
Senninger Wobblers	21	0.56	32	0.28	91	8.4
Hunter PGP Ultra	20	0.35	29	0.18	94	
		10/13/2021				
Senninger Wobblers	21	0.66	51	0.41	106	7.4
Hunter PGP Ultra	20	0.44	34	0.26	86	
		10/18/2021				
Senninger Wobblers	21	0.58	71	0.34	104	9
Hunter PGP Ultra	20	0.46	38	0.33	105	

Figure 6. Distribution uniformity, pressure, application rate, flow rate and wind speed measurements

The results show that valve 20 generally has lower pressures than valve 21, but the wobblers produced a higher distribution uniformity (DU) at any given pressure (Figure 6). The wobblers performed well at pressures as low as 20 psi as indicated in the specs in Figure 5. We installed a pressure regulator at each wobbler sprinkler head so the flowrate of the whole irrigation block was independent of differences in pressure and kept relatively constant (Figure 7). The PGP sprinklers generally performed worse than the wobblers showing DU as low as 0.35, associated with low pressures and high wind speeds. However, when the pressure was 40 psi and the wind speed lower than 4 mph, the PGPs produced a DU as high as 0.7. Wind speeds negatively affected DU for both sprinkler heads, particularly when above 6 mph, but the wobblers performance seemed less sensitive to winds speed (Figure 7).
The wind speed recorded at the site can be relatively high (10 mph) and typically is stronger in the afternoon (Figure 8). Morning irrigations or even programming automatic irrigations at night would result in higher irrigation efficiency.

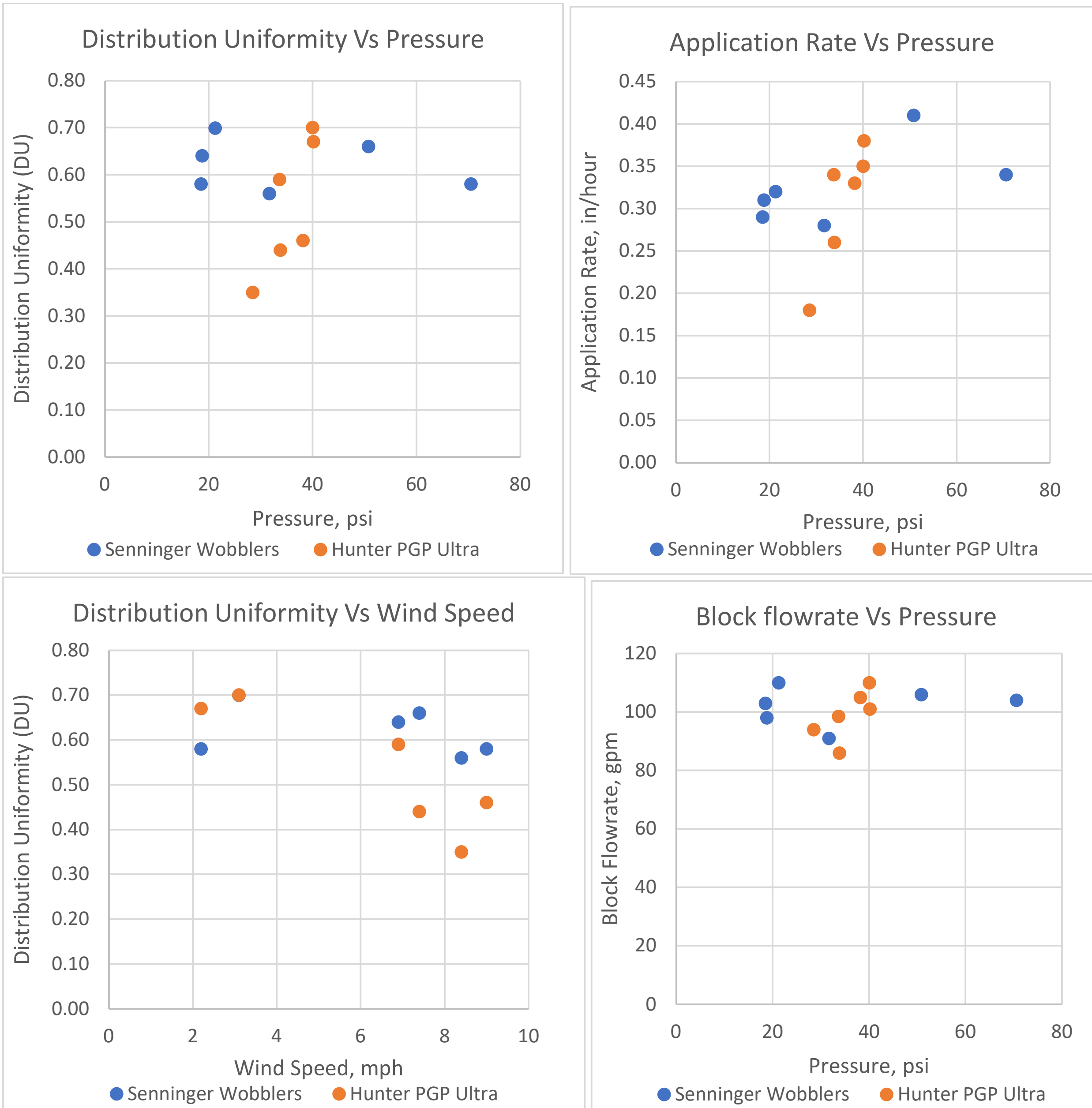


Figure 7. Distribution uniformity, pressure, application rate, flow rate and wind speed measurements

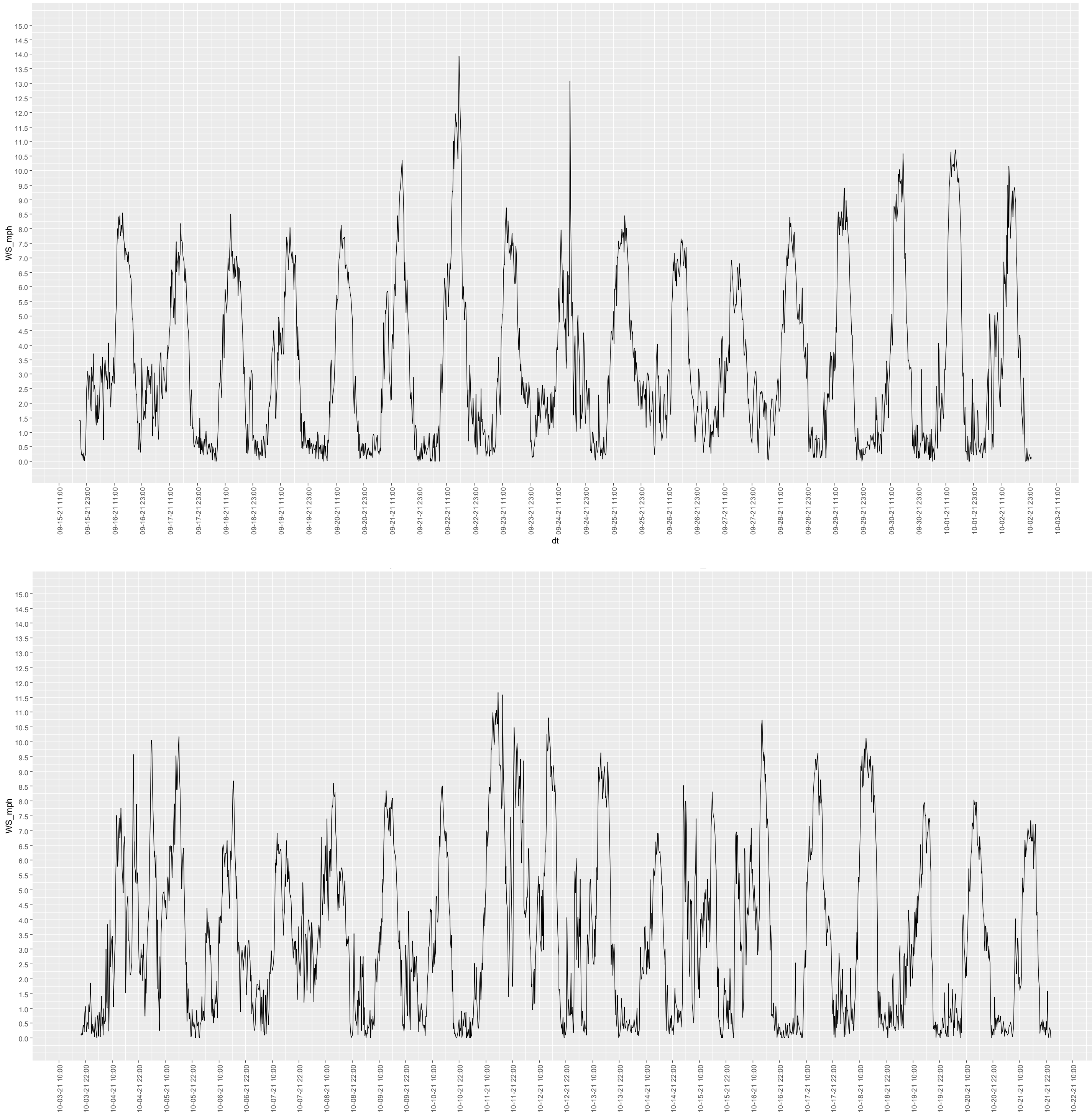


Figure 8. Wind speed measured at the site for the period 9/15 to 10/22.

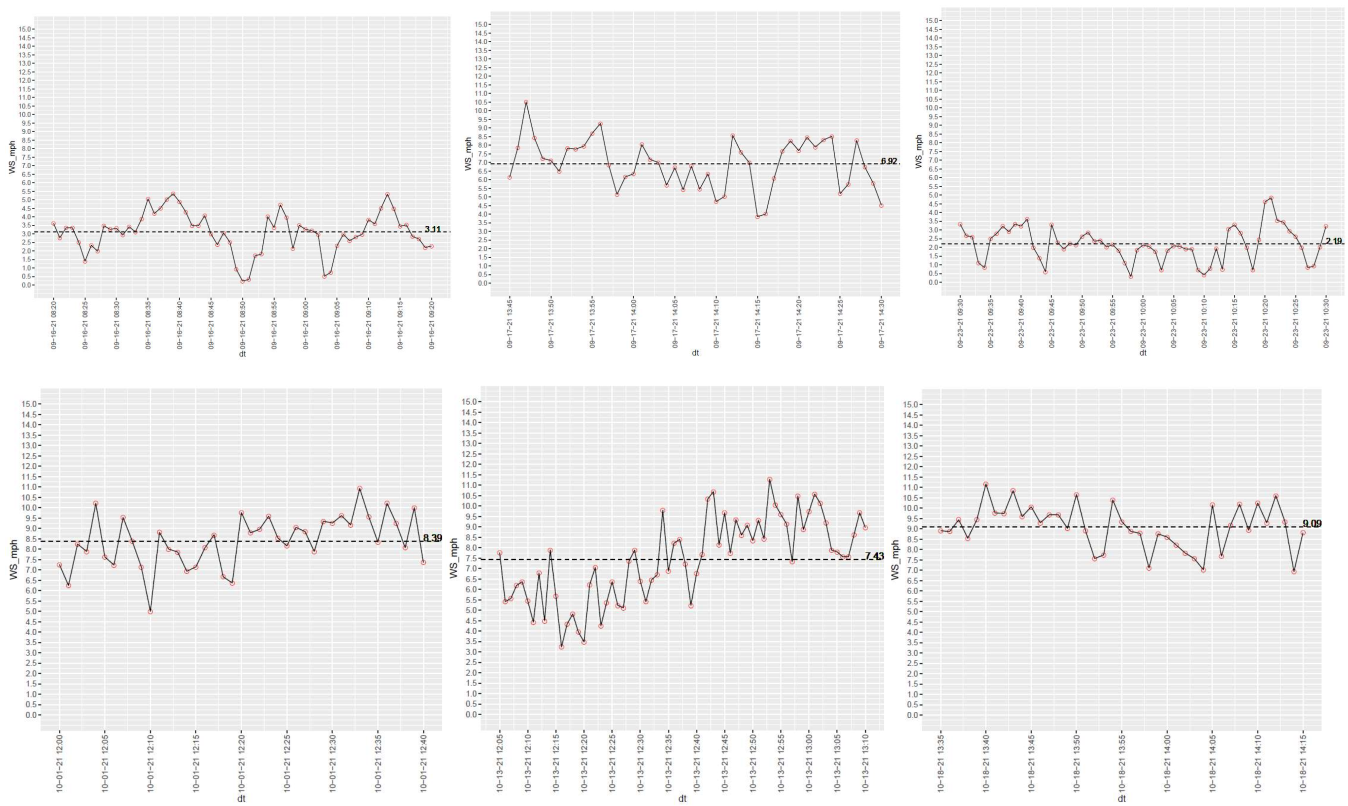


Figure 9. Detail of wind speed recorded during the distribution uniformity (DU) evaluations on 9/16, 9/17, 9/23, 10/1, 10/13 and 10/18/2021.

Figure 10. Buckets set up at the nursery to measure distribution uniformity

Recommendation 3: Irrigation scheduling followed reference evapotranspiration, but containers never reached container capacity and no leaching occurred

We installed water flow meters at valve 21 and 22 to measure water use. We compared irrigation applied to reference evapotranspiration (ET) from the CIMIS station. It is common in nurseries to measure twice as much water being applied as reference ET but in this case the water applied closely followed reference ET, indicating that not a lot of runoff was produced by the monitored blocks.

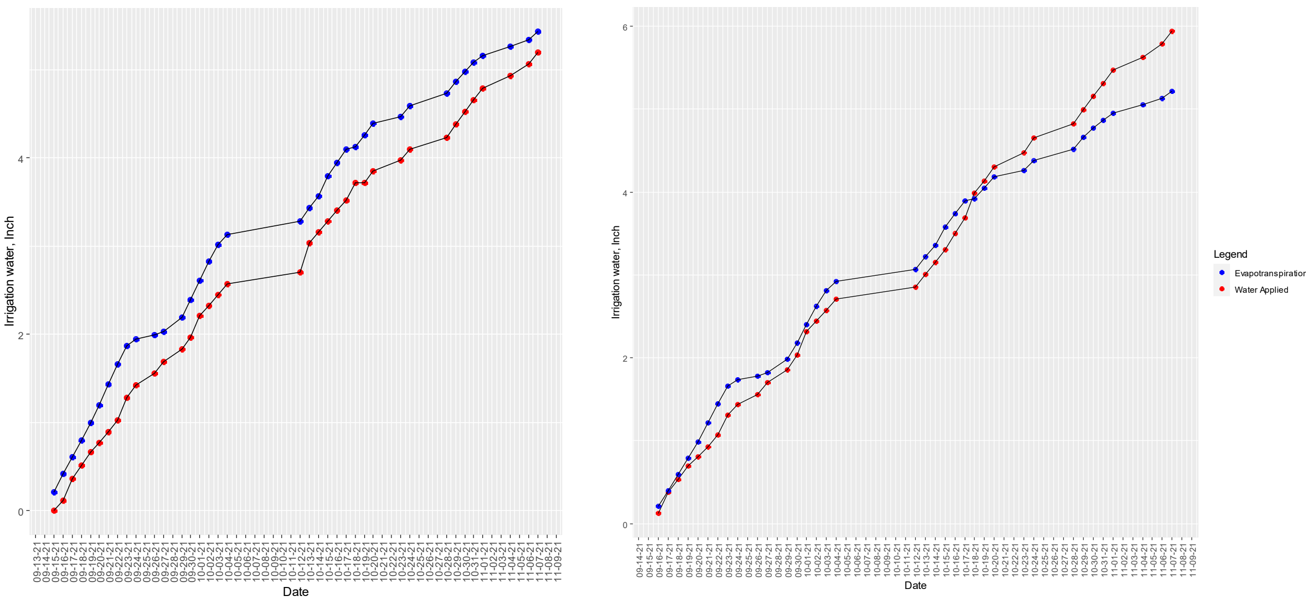


Figure 11. Comparison of cumulative water applied (red dot) and reference evapotranspiration (ETo) from the Escondido CIMIS station (blue dot) for block 20 (left) and block 21 (right).

On 9/2/21 we performed an experiment where we weighted 5 containers before and after irrigation and then after irrigating abundantly until reaching container capacity (Figure 13). The containers, plant and media weighted about 1050 grams before and 1125 grams after irrigations. At container capacity the container, plant and media weighted about 1500 grams (~3 lbs). Then, we let the container dry without irrigation for three weeks and weighted them again. The container, media and plant after drying for 3 weeks without any irrigation, weighted 358 grams.

We also installed a load cell in the field to measure the weight of one container continuously for the period 9/15/21 to 10/5/21 (Figure 12). The load cell indicated that the container weighted about 950 grams maximum (Figure 14). This evidence indicates that the containers did not reach container capacity (that is around 1500 grams) and presumably they would have reached commercial size earlier if the water content of the containers had been kept closer to container capacity. Simply weighting ten pots per block every couple of weeks would have provided the grower and the irrigator a lot of useful information to drive irrigation scheduling decisions. For example, the grower could have responded with lengthening one irrigation (40 minutes instead of the usual 20 minutes) in order to bring the containers closer to container capacity.

	1	2	3	4	5	**Average**
Set up rain gauges		grams	grams	grams	grams	**Average**
Empty leachate container, grams	316	316	320	314	320	**317**
Empty leachate container & potted plant before irrigation, grams	1104	1226	840	968	1140	**1056**
Empty pots with plastic bag, grams	36	36	36	34	36	**36**
IRRIGATE						
Pots with plastic bag after irrigation,grams	104	98	86	94	90	**94**
Leachate container & potted plant after irrigation,grams	1182	1304	904	1034	1202	**1125**
Rain Gauges, mm	2	5				**4**
After draining one hour, leachate container with leachate,grams	316	316	320	316	318	**317**
Empty pots filled with water to brim,grams	2000	1996				**1998**
Irr water intercepted planted pot, mL	78	78	64	66	62	**70**
Irr water intercepted planted pot, %	3.9%	3.9%	3.2%	3.3%	3.1%	**3.5%**
Irr water intercepted empty pot, mL	68	62	50	60	54	**59**
Irr water intercepted empty pot, %	3.4%	3.1%	2.5%	3.0%	2.7%	**2.9%**
Leachate, grams	0	0	0	2	-2	**0**
Capture factor	1.18					
9/28/21 after 26 days without irrigation, gran	362	354				**358**
After dunking in water for 3 hrs and draining	1590	1466				**1528**
Available water, grams	1228	1112				**1170**
Container capacity, %	61%	56%				**59%**

Figure 12. Weighing measurement on 5 pots performed on 9/2/21.

Figure 13. The load cell (left) and the flow meters and anemometer installed at the site.

Figure 14. Weighing containers on 9/2/21

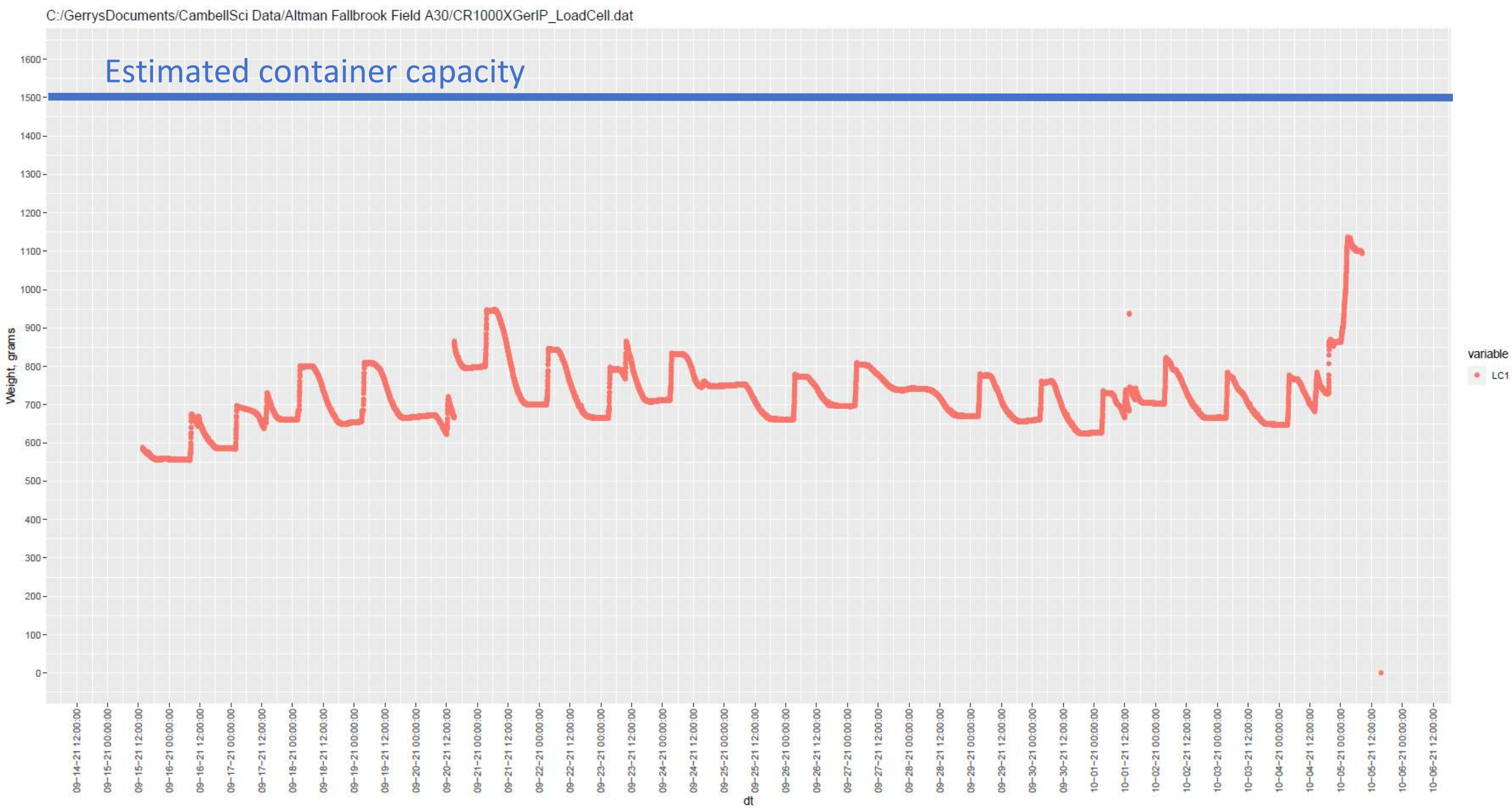


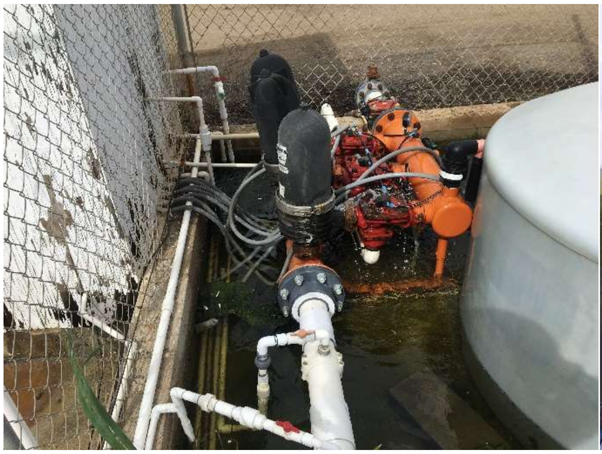
Figure 15. Weight of a container measured continuously. The blue line indicates the weight of the container at container capacity.

Recommendation 4: The water in the pond has high salinity and will require blending to be recycled and reused in irrigation

We took a sample of water from the retention pond and we measured nitrate concentration, pH and salinity. We obtained a relatively low nitrate concentration (42 ppm of NO_3^- or 9.5 ppm of NO_3^--N), high pH (7.85) and very high salinity (EC = 2 dS/m). We recommend blending the pond water with fresh water before using for irrigation and possibly correcting the pH. Pedro said that there used to be an automatic system that blended pond and municipal water based on EC measurements. Repairing this system would be beneficial. We baited for Phytophthora with apple fruits and with lupine seedlings but failed to detect Phytophthora in the pond sampled water.

Figure 16. Measurement of EC and nitrate concentration in the pond water and baiting for Phytophthora with lupine seeds

Recommendation 5: Improve general irrigation system maintenance

We recommend improving maintenance of all irrigation system components, including valves, filters, sprinkler heads, risers, fittings etc. We recommend fixing all leaks in a timely manner. A leak from the disc filter at the A30 injector flooded the tank containment area and went unrepaired for a long time. It would be beneficial to task one maintenance staff with driving around to each block being irrigated to repair all leaks and breakages in the irrigation system. This person could also be in charge of measuring pressure at each block to make sure that is within the specs of the sprinkler heads.