1. Interpreting Sensor Data

Interpreting sensor data is necessary to successfully use the collected data for irrigation control. You have a lot of flexibility in how you set up your own graphs. Doing this in a way that makes sense helps to quickly evaluate the collected data and will improve any decisions made based on the collected data. This module will discuss how to scale graphs for interpretation, the relationship between sensors, and common trends and patterns in data.

2. Scaling the graph for interpretation

Scaling both the x- and y-axis is important for correctly interpreting data and is dependent on how detailed of information is needed. Displaying a narrow range of on the y-axis may result in apparent differences among sensors, even if the values are actually pretty similar. On the other hand, displaying a wide range of values on the y-axis may obscure differences that could be important.

Scaling the x-axis properly, where time is displayed, is important as well. It is possible to display data from a few minutes to months of data. There is not an optimal way to set up graphs; it differs among crops. In crops where things change quickly, such as bedding plants or cut flowers, shorter time scales will be needed than in in production system with slower changes (such as in-ground tree production).

Figure 1. One hour of data. Looking at data on a shorter time scale, such as a minute or hour, can provide a view of what is currently happening, but will likely obscure long-term trends. Note that the readings from the five sensors can be seen, but there is no visible long-term trend.

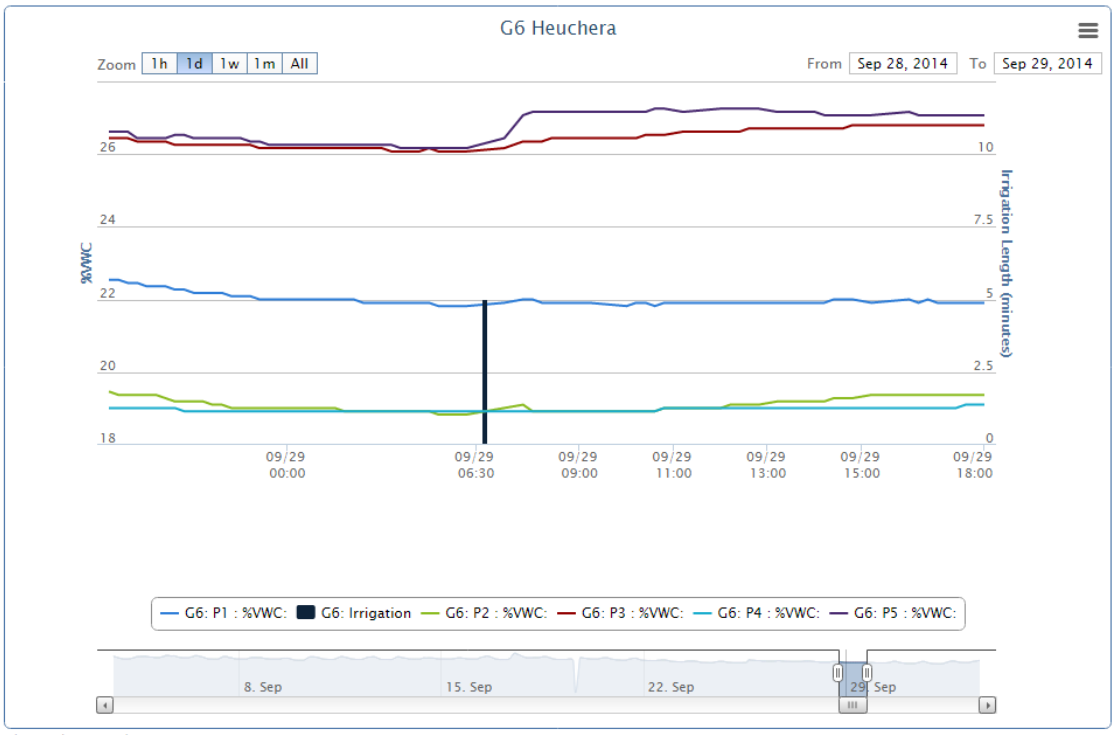

Figure 2. One day of data. The black bar shows an irrigation event, which resulted in a clear increase in the readings from sensors 3 and 5, but without a clear effects on the readings of the other sensors. Some longer term trends are becoming visible.

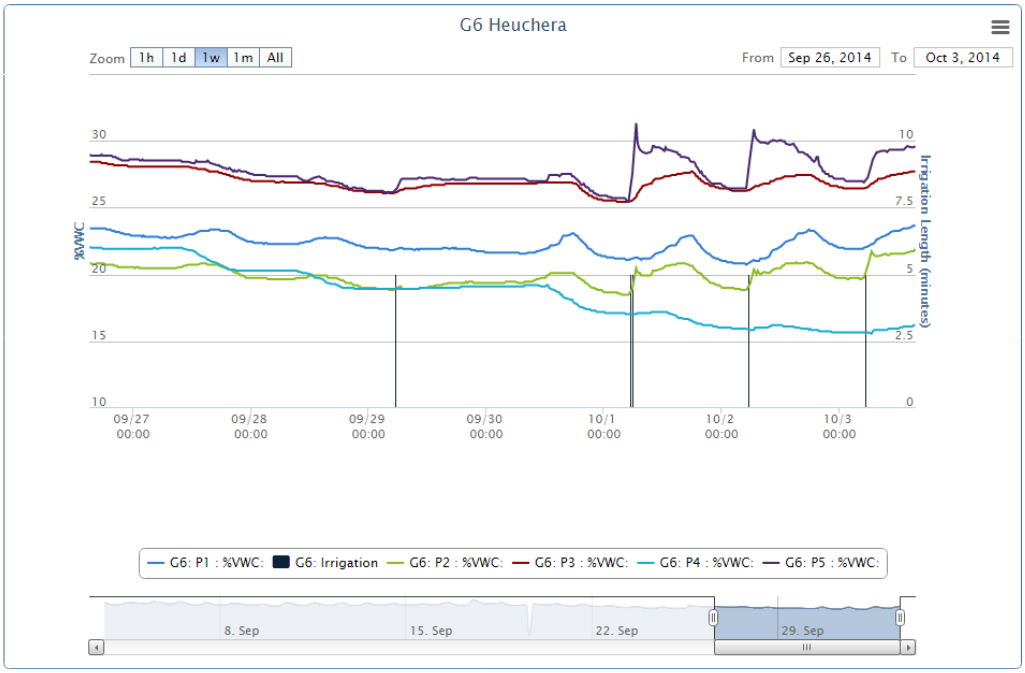

Figure 3. One week of data, with four irrigation events. Longer time scales, which look at data over the course of weeks or months, give a better picture of trends in data. Longer scales are also more useful in looking at the bigger picture of water use and irrigation control.

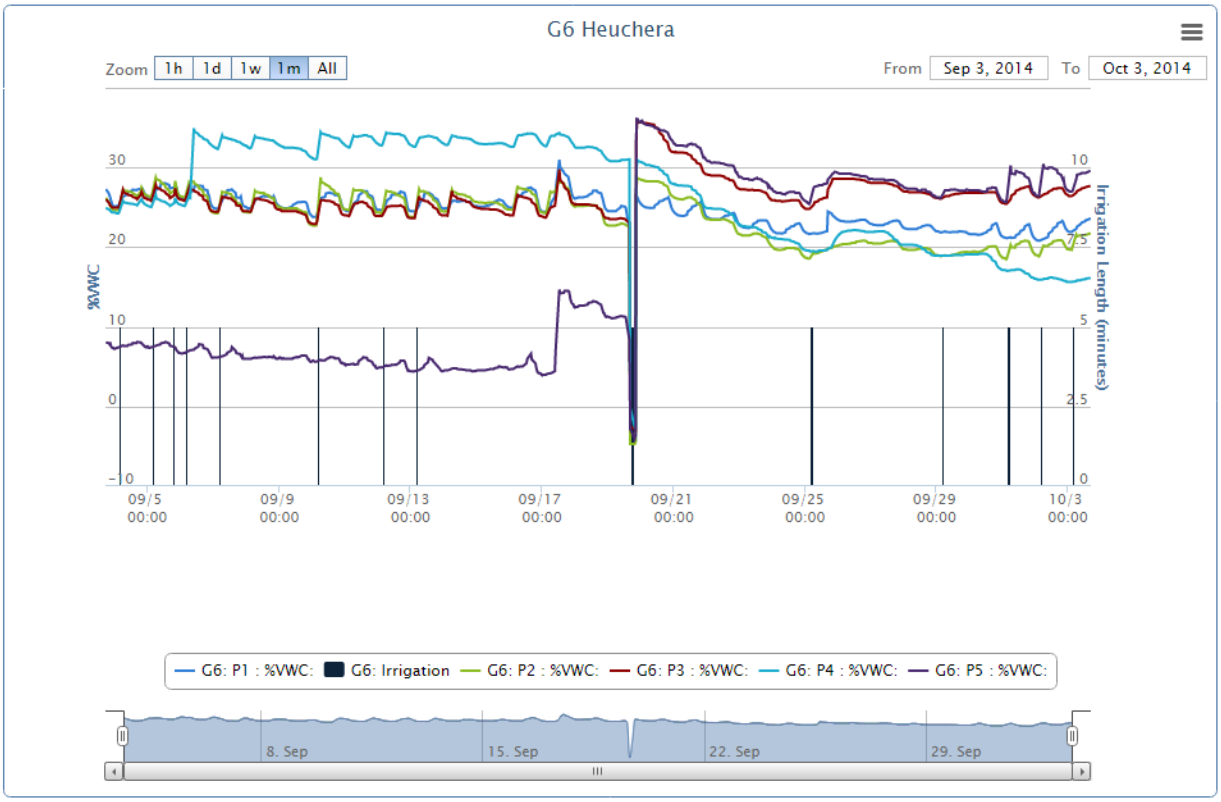

Figure 4. One month of data. During the first two weeks, one of the sensors read consistently lower than the other sensors. On September 20, the sensors were taken out of the pots and reinserted into different pots. Note that the reading from sensor 4 gradually drops after that. It is possible that this sensor is in an area with poor irrigation coverage.

3. The relationship between sensors

Understanding differences among sensors is important for understanding if sensors are reading correctly, for making irrigation control decisions, and for ensuring that sensor placement is correct and/or meaningful for use in irrigation control.

Small differences in volumetric water content reading can be due to natural variability. However, sensors in the same irrigation zone can have different volumetric water content readings for reasons that can impact irrigation control and management decisions.

Figure 5. All sensors are reading similarly, with similar responses to irrigation events. Sensor placement in a container can lead to differences among sensors. Water content gradients exist in containers with substrates generally being driest at the top and wetter at the bottom. It is important when inserting sensors into containers that they are inserted roughly in the same area of the substrate, especially with larger containers. And sensors should be placed in a part of the container with active roots. Sensor placement in an irrigation zone can lead to variability among sensors, especially if irrigation uniformity is an issue. When installing sensors in an irrigation zone, care should be taken to ensure that sensors are not placed in pots in areas that are known to be wet or dry as this could lead to over or under irrigation of the crop as a whole. To minimize such problems, it is important to make sure that the irrigation uniformity as good.

For more information on irrigation uniformity, please see the learning modules on irrigation system design and irrigation system audits.

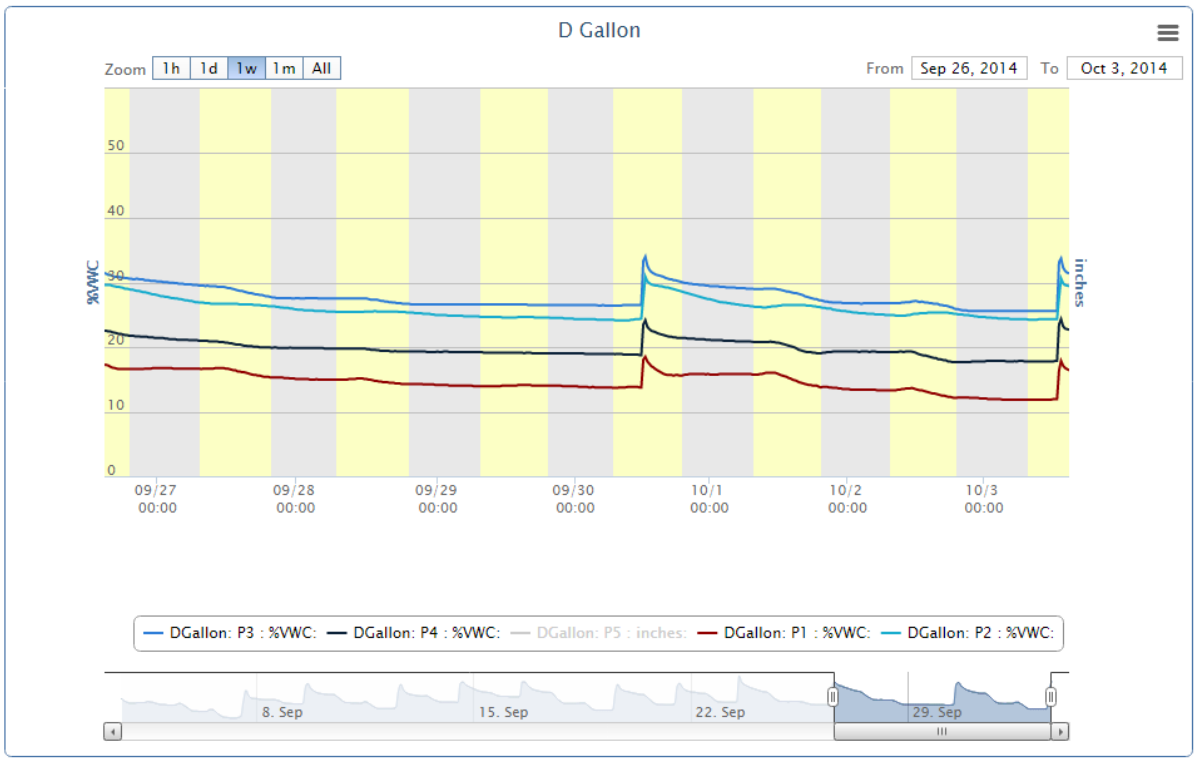

Figure 6. This graph shows that sensor readings can differ, but follow similar patterns due to sensor placement in the pot, pot placement in the irrigation zone, or differences in plant size. In this figure, sensor readings follow a similar trend, however, sensor 2 and 3 (blue lines) read consistently higher and sensor 1 (red line) reads consistently lower than sensor 4 (black line). There are multiple possibilities for why this is occurring:

1. *The blue line represents plants in a wetter area of the irrigation zone while the red line represents a plant in a drier area (variability in irrigation due to uniformity).*
2. *There is variability in sensor placement in the pots.*
3. *The red line might represent a larger plant, which uses more water and thus has a drier substrate.*

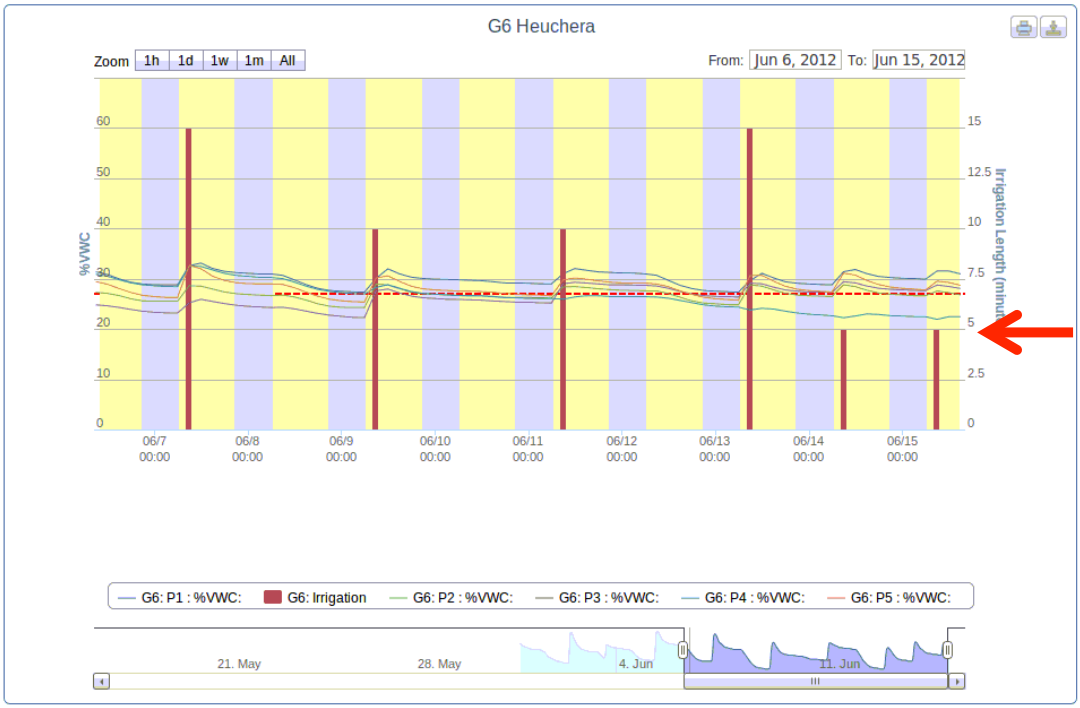

Figure 7. Sometimes one sensor may deviate from the others. This can include responses such as higher peaks, a flat line or small peaks, or an increasing or decreasing trend.

Readings from the sensor represented by the blue line (sensor 2) begin decreasing and do not respond to irrigation similarly to other sensors. This trend is particularly clear during the second half of the period shown. This can happen because this plant may be in a spot with poor irrigation coverage.

4. Common Trends and Patterns

There are common trends and patterns in data that are indicative to what is occurring in terms of individual irrigation events as well as overall irrigation trends.

Gradual increases or decreases over time (days or weeks) can show overall trends in irrigation and/or substrate moisture and can tell you if crops are under- or over-watered.

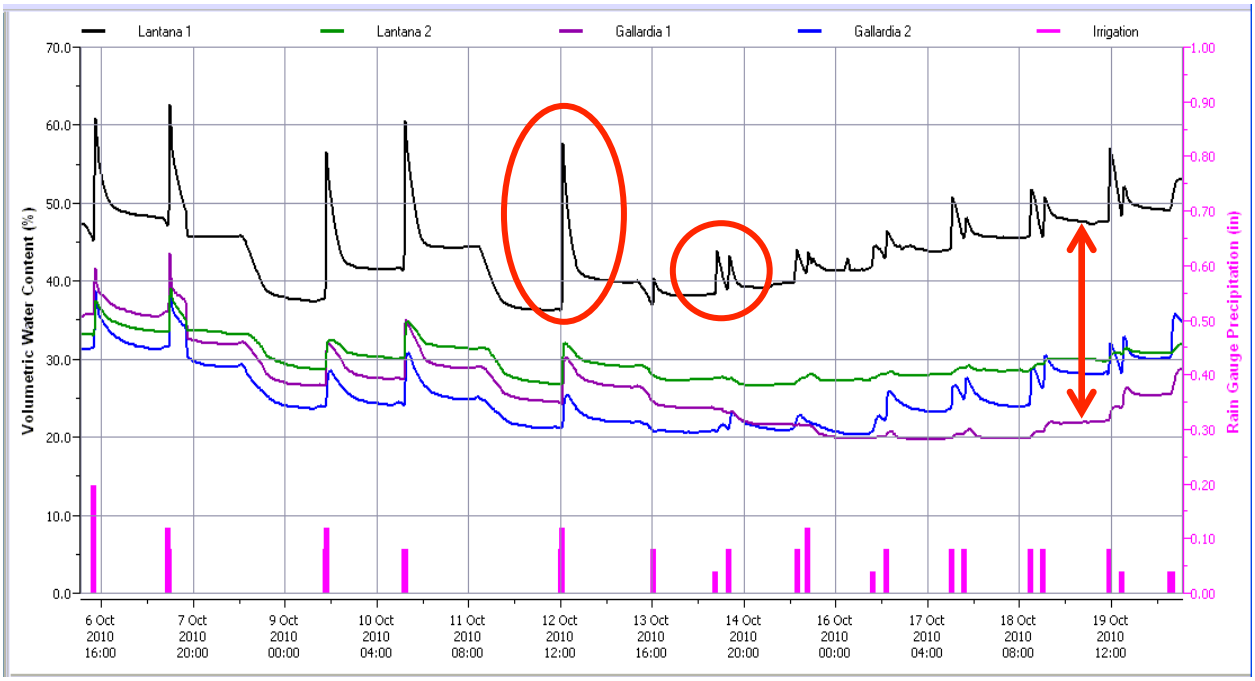

Figure 8. A sharp increase followed by a sharp decrease in volumetric water content (indicated in the left circle) normally represents an irrigation event followed by leaching. In larger containers, it may also indicate that the water has drained to the part of the substrate below the sensor. Multiple peaks close together represent cyclic irrigation or multiple irrigation events. The circle to the right in the graph below shows two irrigation events on one day. This also shows that two shorter irrigation events have smaller peaks, suggesting less leaching. The ideal 'signature' of an irrigation event would be a rapid rise, followed by a gradual decrease in substrate water content (see data in figure 9).

5. Identifying Errors

Some readings indicate that there is a problem with the sensor. Sensors that read extremely high (volumetric water content over 100%) or very low (negative reading) are can be caused by sensors that are broken or that are not plugged into the node tightly.

Sensor readings can also indicate irrigation issues. A rapid increase in volumetric water content for all sensors can mean that a solenoid valve is stuck open or that irrigation is not shutting off properly. An overall decreasing trend may indicate that irrigation is not working properly. An excessively high or low sensor reading may also mean that the sensor placement is not good. The sensor may not have been inserted properly, may be too high or low in the container, or may have been removed from the container.

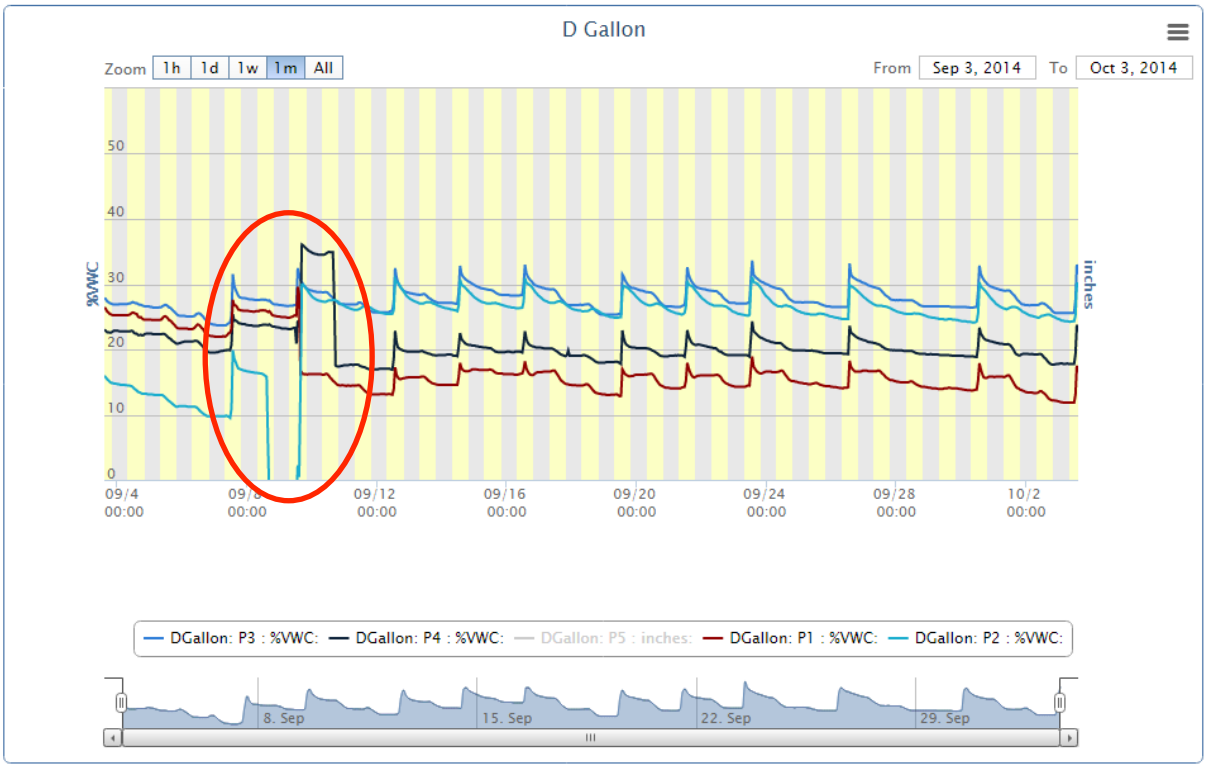

Figure 9. The sensor represented by the green line drops off and then begins reading normal again. The drop in readings was due to the sensor accidentally being removed from a pot and then re-inserted after it was recognized that the sensor was out of range.

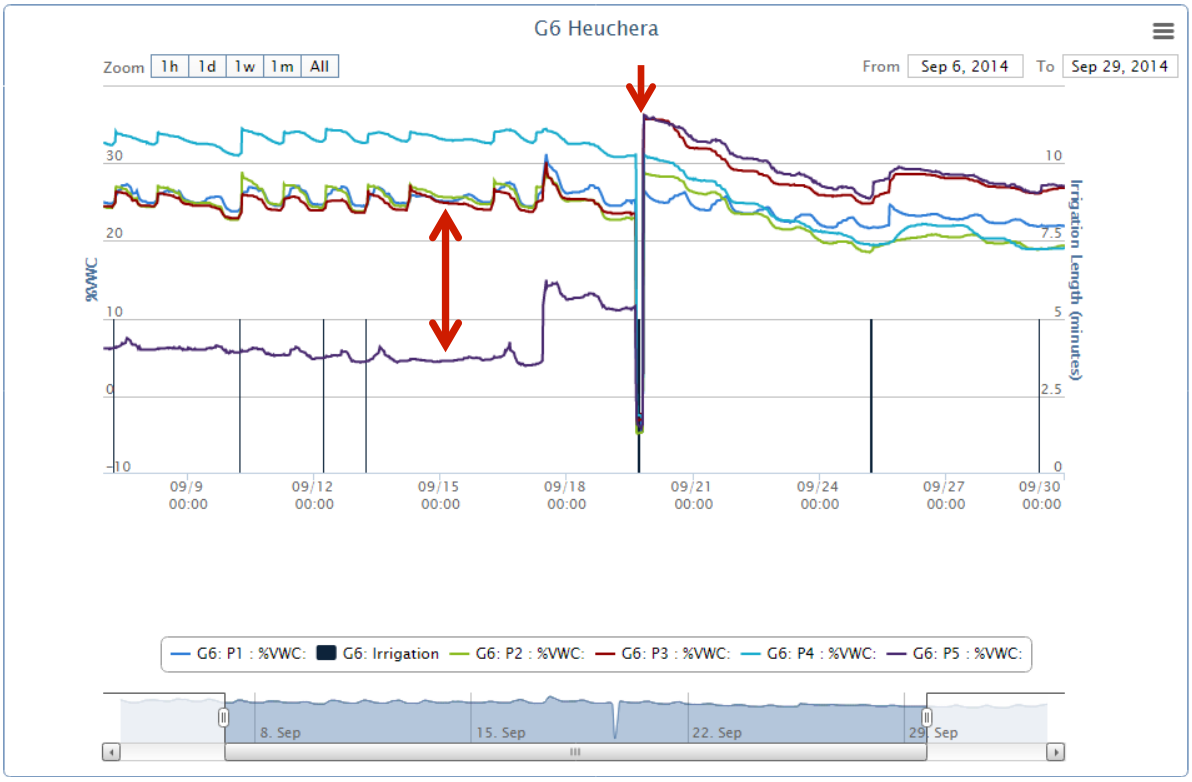

Figure 10. The sensor represented by the purple line is reading much lower than the other sensors. After the sensor is re-inserted into the pot the sensor begins reading within the same range as the rest of the sensors. The initial low readings may have been caused by poor contact between the sensor and substrate. That commonly happens if someone accidentally bumps into the sensor, moving it. That can create air gaps around the sensor that result in artificially low readings.