Selecting the Location to Install Soil Moisture Sensors

This is Grower Guide #2 in our Soil Moisture Sensor Series of guides. This guide covers how to choose the best location to install soil moisture sensors based on vineyard soil and vigor information, including:

- Mapping Vineyard Soils
- Mapping Vineyard Vigor
- Selecting a Representative Location

Related Guides:

- Guide #1 - Soil Moisture Sensor Types
- **Guide #2 - Selecting the Location to Install Soil Moisture Sensors**
- Guide #3 – Soil Moisture Sensor Placement – Depth, Drip Emitter, and Vine Considerations
- Guide #4 – Understanding Soil Moisture Monitoring

Mapping Vineyard Soils

Existing vineyards should have soil maps that were completed before or during the vineyard design process. If your soil maps were completed before planting and show the vineyard soil textures in detail, you can use these maps to accurately determine the locations to install your soil moisture sensors and move on to the next section on Mapping Vineyard Vigor.

If your soil maps lack details on soil textures and soil boundaries, you will need to have your vineyard mapping redone before determining the locations to install your soil moisture sensors. You may be able to use your existing map and simply collect additional soil samples to determine the organic matter content and texture (sand/silt/clay components) of your soil if you have a map with defined soil boundaries.

Maps from the USDA-NRCS are helpful to generally describe the soil type of an area. These soil maps show the approximate boundaries of distinct soil series and can serve as a good starting point for determining where soil may change within a site. However, they are not accurate enough to be relied upon without further testing to select exactly where to install soil moisture sensors.

Before Planting…

A vineyard's soils should be fully mapped before designing a vineyard and establishing irrigation blocks. Different soils may need to be irrigated differently and this could impact vineyard block design. General soil maps are available online from the United States Department of Agriculture, National Resource Conservation Service (USDA-NRCS) - Web Soil Survey (Figure 1).

If you don't already have a soil map, on-site mapping of vineyard soils by a soil scientist or vineyard soil expert is recommended to understand the precise boundaries of different soil types. Soil characteristics that may change across a soil series include effective rooting depth, depth to bedrock or a hardpan layer, soil texture, and depth of distinct soil horizons.

Before Planting…

Soil pits can be excavated using a backhoe to see more complete soil horizon information. Hand or electric-powered augers will disrupt less soil volume on a site while still allowing you to see changes in the soil profile.

Mapping soils involves excavating multiple soil observation pits across a site to establish where changes in soil characteristics occur. The potential influence of different soils characteristics on plant growth can be estimated based on the knowledge and prior experience of a soils expert. Within a planted vineyard, power-operated or hand soil augers can also be used to capture disturbed soil profile samples and assist in delineating changes in soil across a block.

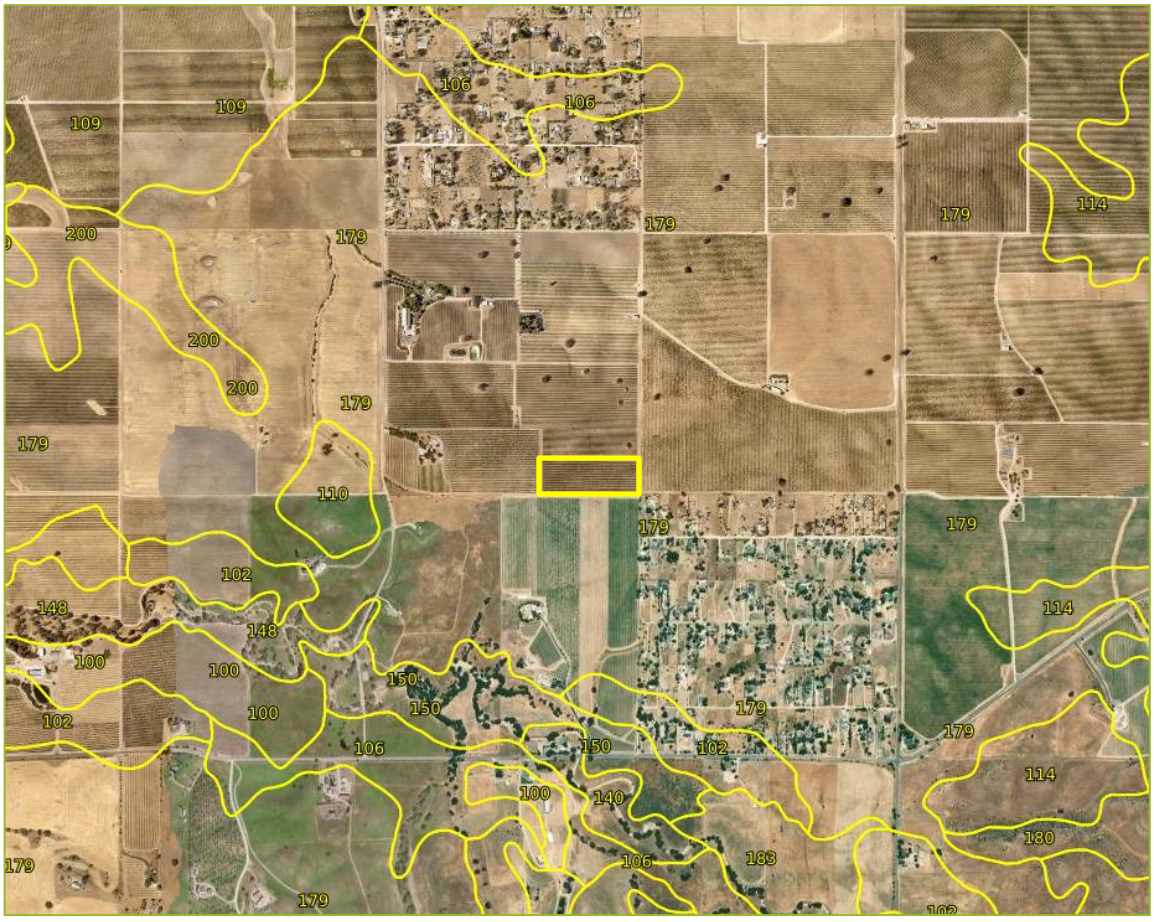

Figure 1: Fine yellow lines outline the soil series as identified by the NRCS Web Soil Survey and the block of interest is outlined in the yellow box.

Mapping Vineyard Vigor

Differences in soil characteristics across a vineyard block can impact canopy growth and vine vigor. So, the second step in determining the best location(s) to install moisture sensors is to determine areas in the block with normal or average vigor, and possibly lower than average vigor if underwatering is a concern.

While the easiest way to map vineyard vigor is with a Normalized Difference Vegetation Index (NDVI) map, this kind of mapping can be costly for a small vineyard. Please see **Appendix A** below if you want more information about matching an NDVI vigor map with soil mapping. The most common way to evaluate vigor across a smaller vineyard or vineyard block is through visual observation and dormant pruning weights.

Visual vigor assessment can be done from an aerial view (i.e. with a drone) or simply walking through the vines and categorizing areas of higher and lower vigor. This should be done around mid-summer to see the contrast between higher and lower vigor areas of the vineyard. High vigor usually denotes a very full, dark green canopy with little to no missing spaces on the cordon/cane. Lower vigor might entail stunted shoots potentially with little to no fruit and missing shoots along the cordon or cane. In order for the area of the vineyard to be classified as “lower vigor” these symptoms need to be replicated in neighboring vines. If it is a single vine showing stunted shoots, it could be trunk damage or disease and not related to soil vigor.

Figure 2: Dormant canes from a spur-pruned vineyard lined up and ready for individual vine pruning weight data collection.

Pruning weights are taken during dormant pruning by measuring the weight of only the dormant one-year-old canes (the formerly green growing shoots from the past season). This measurement is usually taken per vine over a representative sample of vines in a block (such as between line posts). The heavier the pruning weight, the more vigorous the vine grew during the growing season.

The best place for a soil moisture sensor to be installed would be in an area of average vigor for the block as shown in both dormant pruning weights and visual vigor assessment. A grower may choose to install the sensor in a slightly lower than average vigor spot if they are concerned about underwatering the lower vigor areas of the vineyard. Low vigor areas should also be remediated with soil amendments to reduce the incidence of underwatering.

Selecting a Representative Location

Ideally, a grower would install soil moisture sensors in multiple locations per irrigation block to obtain an average of soil moisture across a site. However, due to the cost of sensors and the associated telemetry devices, many growers only install moisture sensors in one or two locations per irrigation block. Because of this, it is essential to select an install location that has a soil profile that best represents the majority of the irrigation block.

- Installing soil moisture sensors in an area of shallow soil or with less water holding capacity than is typical of the whole block can result in sensor readings that overestimate the water needs of the whole block.
- Installing sensors in an area with deeper, heavier clay soil than is typical of the block will result in sensor readings that potentially underestimate the water needs of the whole block

To pick the area with the most representative soil profile for the block, you can take a series of soil cores in the average vigor area you select from your soil and vigor map. In the below example (Figure 3) we see a photo of four disturbed soil cores taken with a four-inch diameter hand auger in the 8-acre Cabernet Sauvignon block of interest.

- The (A) soil sample came from a higher vigor, swale area with the lowest elevation. It has a deep clay content of up to 4 feet.
- The (B) and (C) samples came from east of the swale in the middle of the block
- The (D) sample came from the highest elevation east of the block and has a heavy clay topsoil that quickly transitions to loam at about 2 feet.
- The two cores from the center of the block (B, C) are of the most representative soil, having a sandy clay loam topsoil, transitioning to clay loam, then loam subsoil.

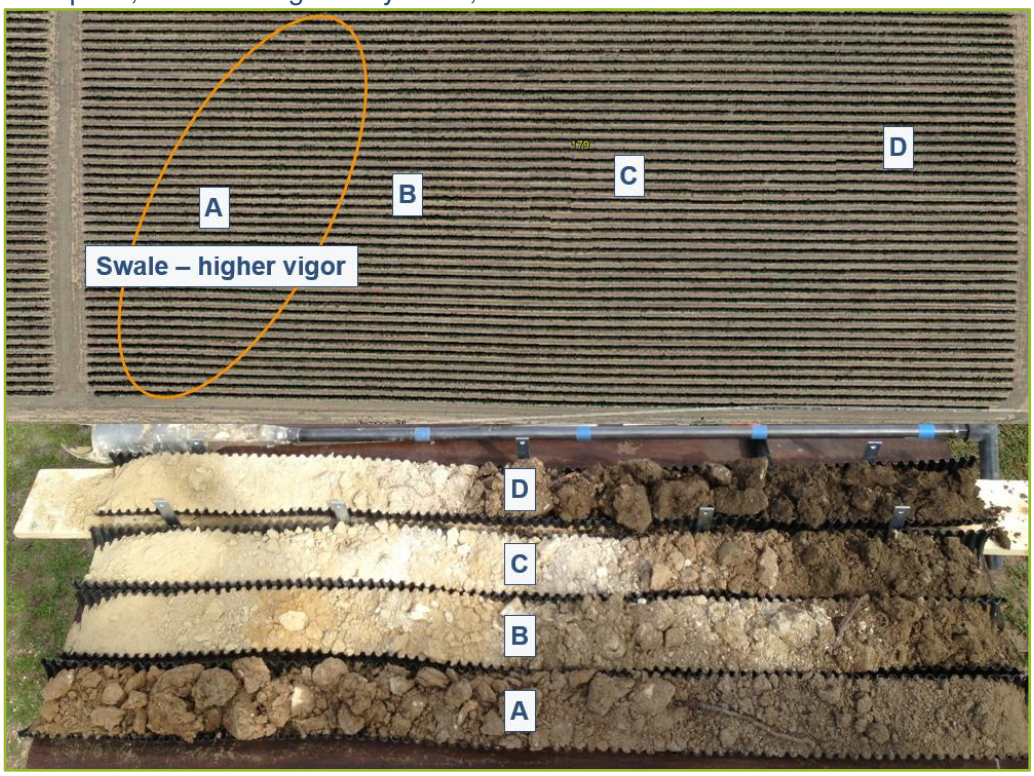

Figure 3: An 8-acre block of Cabernet Sauvignon is planned as a single unit for irrigation. Soil cores extracted to a depth of 4 feet from west to east (A, B, C, D) reveal differences in the depth of soil horizons across the block.

Proper Placement within Soil Horizons

The two most representative cores have been identified as core (B) and core (C) in the above figure. The next step is for the grower to lay out a series of grid points around cores (B) and (C) for further sampling to find the most representative soil horizon depth within this target area. Figure 4 illustrates a grid of points where disturbed cores were taken to evaluate soil horizon depth within the (B) and (C) sample areas.

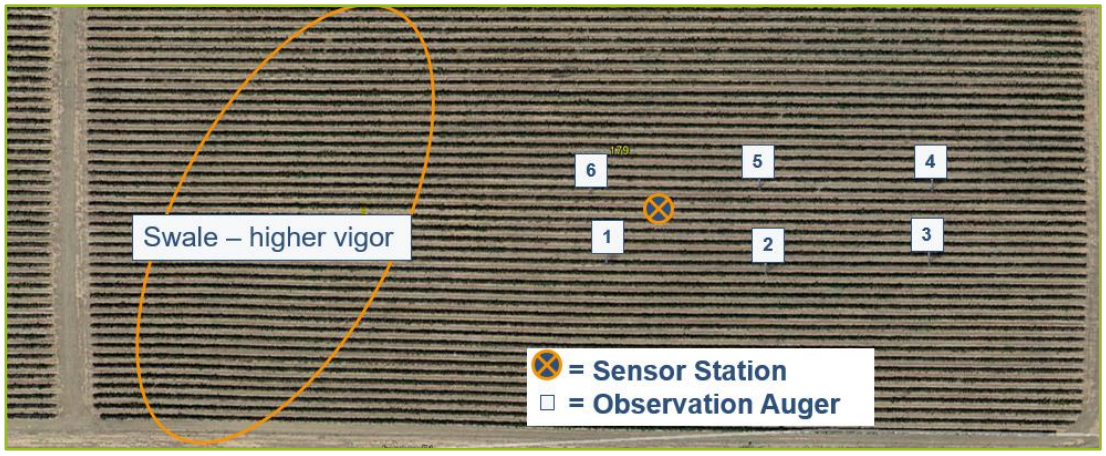

Figure 4: A grid pattern is devised for the evaluation of soil cores on the area of the block that represents the most common vigor patterns from NDVI mapping (1, 2, 3, 4, 5, & 6).

The location for soil sensor placement should be chosen in an area that represents the most commonly observed soil profile across all sample sites (near locations 1, 2, 4, or 6) as determined by visual observation using an auger or excavation pits (Figure 5).

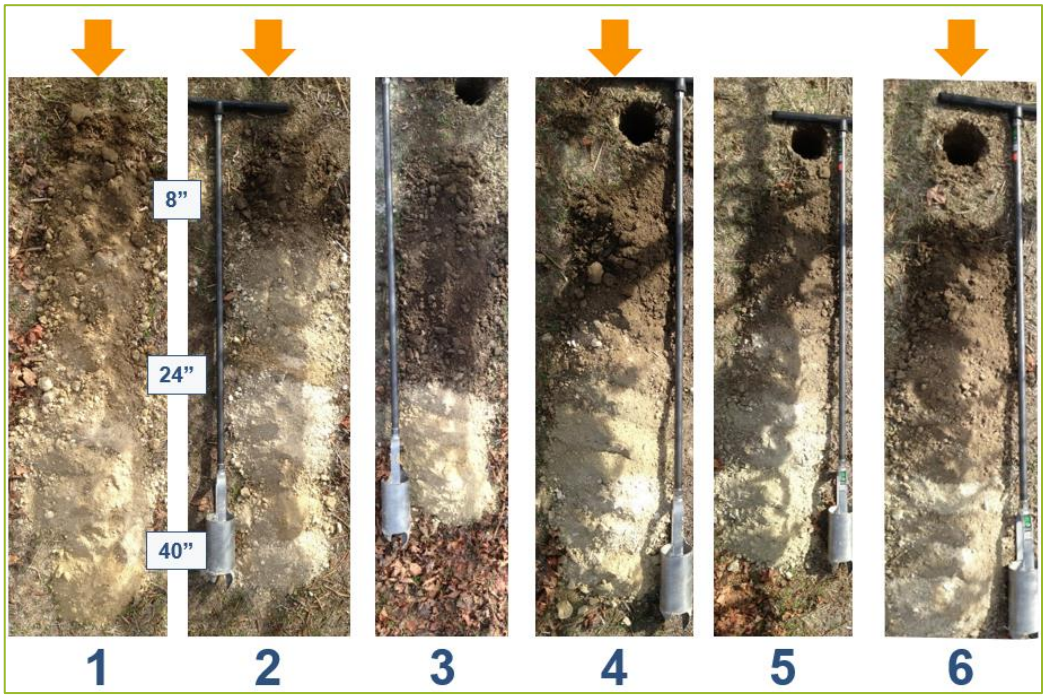

Figure 5: Disturbed soil cores excavated with a hand auger are laid out on the vineyard floor for visual evaluation. The arrows indicate profiles that are visually more representative of the block.

Resources

United States Department of Agriculture, National Resource Conservation Service – Web Soil Survey (HTTP://WEBSOILSURVEY.SC.EGOV.USDA.GOV/APP/HOMEPAGE.HTM)

Peters, T. R., Desta, K., and Nelson, L. 2013. Practical Use of Soil Moisture Sensors and Their Data for Irrigation Scheduling. Washington State University Extension Fact Sheet – FS083E

Related Grower Guides

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- Guide #3 – Soil Moisture Sensor Placement – Depth, Drip Emitter, and Vine Considerations
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- **Installing a Capacitance Soil Moisture Probe in the Vineyard**
- **Installing Capacitance Soil Moisture Sensors in the Vineyard**

Appendix A

The Normalized Difference Vegetation Index (NDVI) mapping can be used for tracking differences in vegetative growth across a vineyard (Figure 6). NDVI images provide a snapshot in time (e.g., mid-summer) when the relative canopy size and health can be compared within a vineyard block.

Placement of soil moisture sensors in uncharacteristically higher (represented by dark green) or lower (represented by yellow to red) NDVI areas can result in some areas being overwatered, and others underwatered.

The target area for installing a soil moisture sensor would be an area that is consistently shaded in medium green on the NDVI map as the most representative or average area of the vineyard for water uptake.

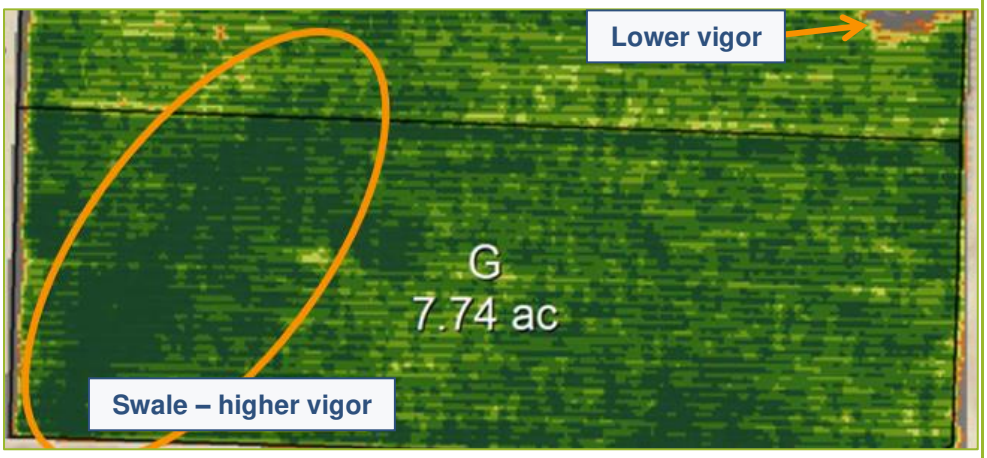

Figure 6: Normalized Difference Vegetative Index (NDVI) map of an existing vineyard shows areas of high vigor in dark green and those of progressively lower vigor in yellow, orange, and red. A combination of deeper clay soil and the drainage pathway provided by the highlighted swale are the likely reasons for higher vigor. Soil sensors should not be placed in these areas if the data is to be representative of the majority of the block.

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