

BOISE FOOTHILLS

RESTRICTED IRRIGATION STUDY

PURPOSE: This study investigates the ability to establish productive wine grapes using different levels of limited irrigation in the Boise Foothills located in an arid climate.

SITE DESCRIPTION:

The West Foothills TIC Vineyard (TIC) is located in the Boise Foothills (Figure 1) in a climate zone receiving less than 300 mm of annual precipitation. The area consists of steep to moderate slopes with grades from 15 to 30 percent. TIC is situated on a west-northwest-facing slope. The natural vegetation is dry and predominately cheatgrass and rush skeletonweed along with some native grasses and shrubs. A textural analysis of the soils across the vineyard shows a homogeneous medium sand soil throughout.

About 1,000 Tempranillo vines are spaced 3.0 m by 3.0 m apart. This cultivar was selected because of its ability for head training, similar to dry farming practices in Spain, the native origin of Tempranillo, and it naturally roots deep in sandy soils. The relatively low planting density allows the plants to find and use water free from competition.

STUDY SETUP:

The vineyard is divided into three test blocks on a west-northwest-facing slope. Traditional vineyard performance factors, such as planting densities, soil type, rootstock, and climate, are standardized and serve as constants in this study. Thus, the limiting factor for vine performance is the difference in irrigation on each block. Each block is about an acre in size. Decagon EC-5 sensors were installed at two sites in each block-- one at a higher elevation (denoted A), and one at a lower elevation (denoted B). There were also sensors installed at a control site located upslope (Figure 1).

2011: Sensors were installed at depths of 0.25 m and 0.50 m at high (Figure 1, A) and low elevations (Figure 1, B). The sensors are located 0.50 m downhill from a vine and the emitters vary from 5 to 20 cm uphill from each vines.

2012: Additional sensors were installed at depths of 0.25 m and 0.50 m at the higher elevations in each plot (Figure 1, A). These sensors are located directly next to the plants. All of the emitters were adjusted so they are about 5 cm uphill from each plant.

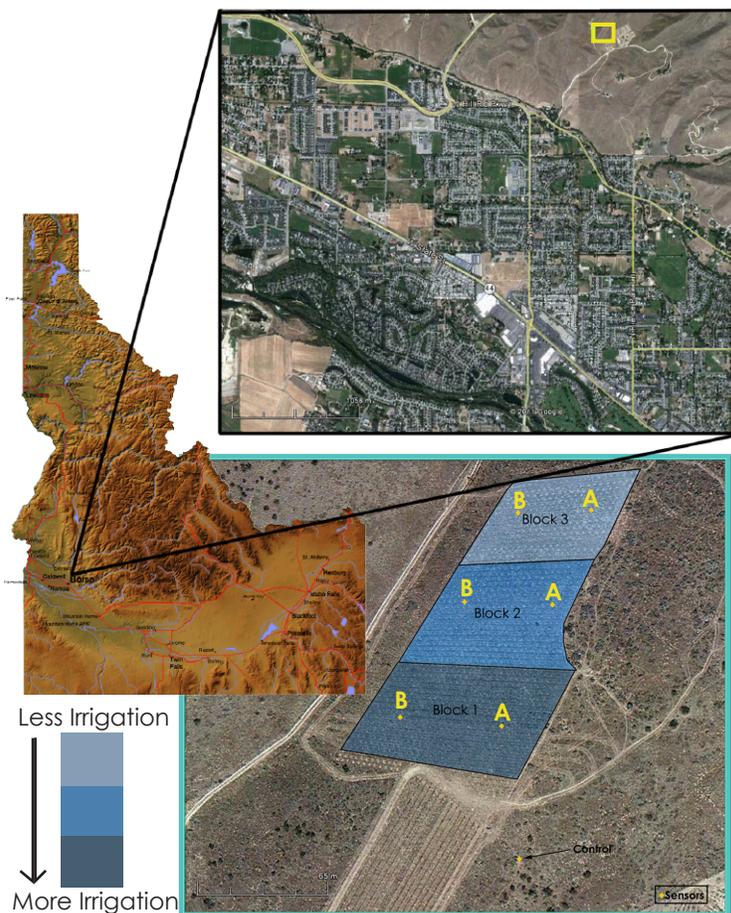


Figure 1: Location Map and Study Area. Sensor locations are shown; those labeled A are at higher elevations and those labeled B are at lower elevations. Those labeled A have paired sensors, a set at the plants and a set 0.50 m downhill. The difference in irrigation is noted by varying shades of blue. Map source: Google Earth

IRRIGATION:

A gravity-fed drip irrigation system feeds from a tank at the top of the hill. Each vine has access to water from one pressure-compensating drip emitter. The area was irrigated from June to October in 2011 and mid-April to October (with a break from late April to mid-May) in 2012.

Block 1: 1 gallon of water twice a week or 2 gallons total

Block 2: 1 gallon of water once a week

Block 3: 0.50 gallon of water once a week

BOISE FOOTHILLS RESTRICTED IRRIGATION STUDY

SOIL MOISTURE FOR HIGH AND LOW ELEVATIONS IN EACH BLOCK

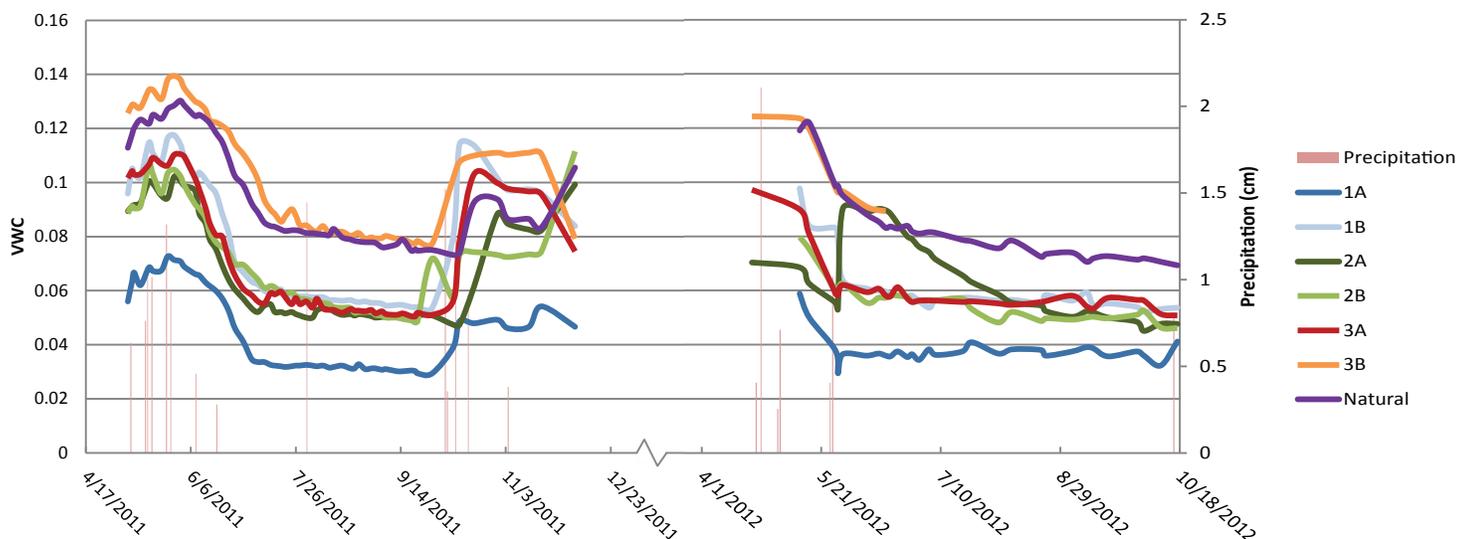


Figure 2: The volumetric water content (VWC) is plotted over the 2011 and 2012 growing seasons across all blocks. Each line represents the mean VWC values of the sensors at 0.25 m and 0.50 m depths at each site. The sensors used for this graph were all located 0.50 m downhill from the vines. Precipitation events greater than 2.54 mm are also shown.

SOIL MOISTURE:

Soil moisture is reported as volumetric water content, which refers to the fraction of water in the soil. Monitoring occurred approximately three times a week for all sensors. Some data are missing due to equipment complications.

Figure 2 displays the data for the soil moisture 0.50 m downhill at each site. The irrigation does not have a great effect on the soil moisture at that point. Based on the consistently drying-down trend during the summer season at all sensors, there appears to be very little change in the soil moisture at those sites resulting from irrigation. Minor increases resulting from precipitation events support this, especially in the spring when the evaporation rates are lower. This indicates that the water delivered through limited drip irrigation input was dispersing as far as the sensor, which implies the plants are not being overwatered. The sensors appear to show, instead, the natural dry-down of the soil as opposed to the effects of irrigation. The lower elevations contained more moisture averaged over the season. Results show this soil moisture difference, with elevation difference, in each block to be consistent.

CHANGES IN SOIL MOISTURE AT PLANT AND DOWNHILL OF PLANTS

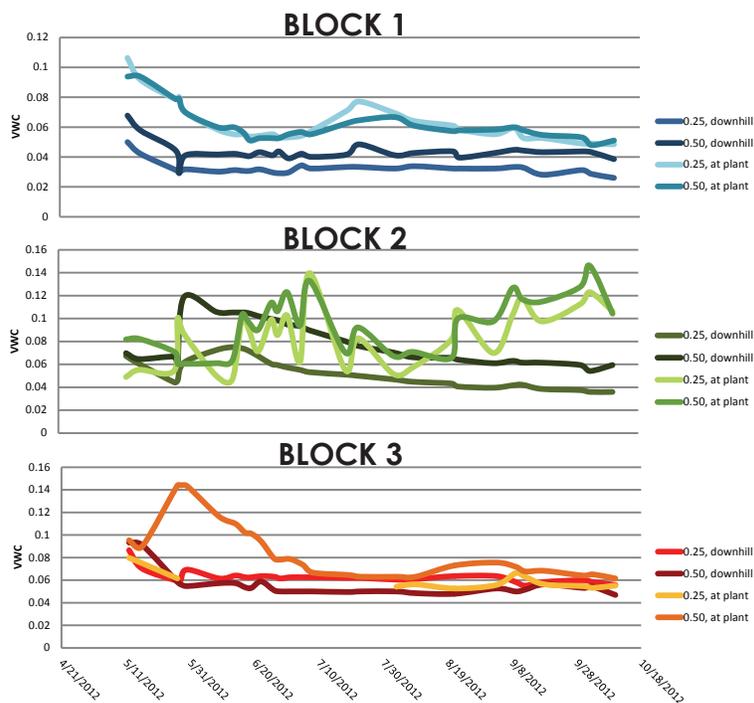


Figure 3: The volumetric water content (VWC) is plotted over the 2012 growing seasons across all blocks for the higher elevation paired sensors. Each line represents the VWC values of the sensors at either 0.25 m and 0.50 m depths and either 0.50 m downhill of the vine or at the vine.

BOISE FOOTHILLS RESTRICTED IRRIGATION STUDY

SOIL MOISTURE:

Figure 3 shows the difference in soil moisture from higher to lower elevations. Overall the soil moisture is higher at the vine than it is downhill from the vine, which shows the diffusion of the water as it moves downslope through the soil profile.

Block 1: VWC values do not vary drastically in this block. Lack of moisture variations could be due to the frequency of watering. The block is watered twice a week as opposed to once a week like the other blocks allowing for more stable soil moisture.

Block 2: The values for sensors at the vines at both depths are very variable. The values appear to be responding to irrigation inputs because the days where the soil moisture is high correspond to days directly following irrigation.

Block 3: Very little variation occurred in soil moisture values for all sensors in Block 3. This disregards the high values in the 0.50 meter-deep sensor at the plant, which are probably due to the sensor adjusting or a local variation in the soil after the sensors were installed. The peak corresponds to the time the 0.25 meter-deep sensor stopped reporting data most likely due to a gopher chewing through the wire. The presence of gopher tunnels could have disrupted the flow of water in the soil as well. The data appear to show low variation in the soil moisture at the plant and downhill from the plant because there is not enough irrigation input to have a visible effect on the soil moisture at those depths.

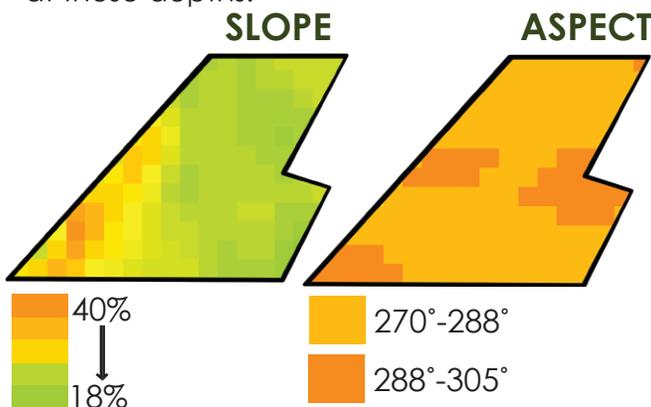


Figure 4: Slope and aspect maps for the whole vineyard showing the local variations throughout.

MEASURES OF PRODUCTIVITY:

Productivity of the plants was measured by plant health and mortality for each year. Figure 5 shows the health of the plants near the end of each growing season. Productivity rate statistics are displayed in the tables for each block of differing irrigation and the vineyard as a whole.

MORTALITY RATES BY YEAR:

	Block 1	Block 2	Block 3	Whole Vineyard
2011	11.23 %	6.30 %	27.19 %	13.86 %
2012	34.19 %	33.63 %	63.52 %	40.71 %
Total	41.58 %	37.81 %	73.44 %	48.61 %

MEASURES OF PRODUCTIVITY:

	Block 1	Block 2	Block 3	Whole Vineyard
Healthy	35.96 %	36.16 %	15.00 %	30.68 %
Stressed	22.81 %	26.30 %	10.63 %	20.71 %
Total Alive	58.77 %	62.47 %	20.17 %	51.39 %

VINEYARD PRODUCTIVITY:

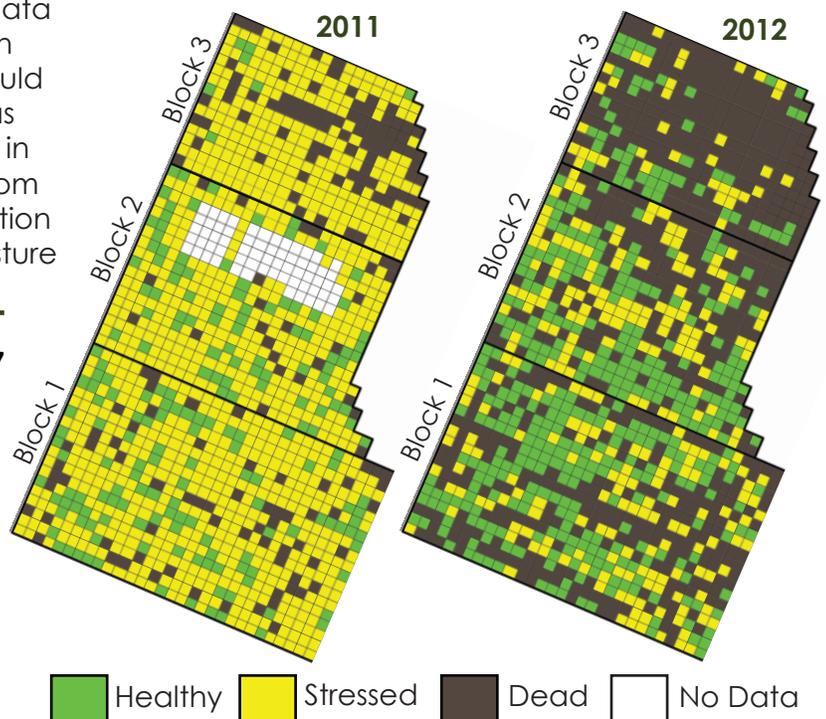


Figure 5: Productivity across all irrigation blocks for 2011 and 2012

BOISE FOOTHILLS

RESTRICTED IRRIGATION STUDY

PRODUCTIVITY RESULTS:

- The higher mortality rates in Block 1 over Block 2 suggest that other localized factors within the vineyard (perhaps due to slope or aspect shown in Figure 4) are having an effect on soil moisture along with irrigation input. Greater injury to plants during the spring freeze was observed in Block 1 because these plants budded early (~May 20) and were unable to recover from loss of first growth.
- The high mortality rates for Block 3 (73.44% total mortality) and the very little difference in the paired soil moisture sensors (Figure 3) at that site suggest that 0.50 gallon of water per plant per week was not enough to keep the vines alive.
- The overall survival rate of the vines across the vineyard (51.39%) suggests the current model for the vineyard is not productive. Vine establishment (or lack of) was affected by annual weather events, which cannot be controlled. Nonetheless, with some changes to methodology there exists a possibility to establish a productive limited irrigation vineyard in the lower Boise Foothills.



SETBACKS AND POSSIBLE SOLUTIONS:

Year-to-year climate variability added difficult conditions in predicting plant productivity with limited irrigation input. The two growing seasons for this study both had very different seasonal weather. Spring of 2011 was exceptionally wet, where 2012 was dry. Both summers were very dry with almost no precipitation from July to September. In 2012 the summer temperatures were very high and exceeded 100°F for longer than a week, peaking at 109° on July 12. Precipitation and temperature variations add stress to the plants and, in addition to the stress they experience from limited irrigation, could result in mortality.

Another climate complication was the 2012 late spring freeze. Temperatures rose in mid-April and many of the healthy plants from 2011 started growing. A series of freeze events from May 4-7 severely damaged many of the plants. The mortality rate of 13.01% for the healthy vines from 2011 to 2012 is likely a result of frost damage and weather stress as opposed to the limited irrigation.

One of the complications with the current setup is that one emitter per plant limits the watering zone. The plants would likely respond better with low irrigation if they were watered with two or more emitters per plant to increase the watering zone, and watered less, but more frequently. This would maintain more stable soil moisture values over a larger zone for each vine, hopefully reducing water stress to the vines. Watering the vines more as they are being established and then less in following years may also reduce mortality. This allows the plants to develop good root stocks and more vigor to endure greater water and climatic stresses.

Joseph Guenther, West Foothills TIC Vineyard
David Wilkins, Boise State University
Jenna Duffin, Boise State University

Project funded by

