

FINAL REPORT – 2009 PROJECT PERIOD

Project Title: Deficit Irrigation of Cabernet Sauvignon and Tempranillo: Impacts on vine growth, yield, and berry composition

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Cooperator(s):

The owners and managers of the below listed businesses will be included as site cooperators, providing access to reference vineyard blocks.

Alex Cabrera
Abacela Winery
UmpquaValley

Chris Martin
Troon Winery
Applegate Valley

Richard Ellis
Ellis Vineyard
Bear Creek Valley

Dr. Steven Petrovic
Chair, Dept. of Chemistry
Southern Oregon University

Steve Renquist
OSU- CE Douglas County
Roseburg

Summary

As funding was not awarded until well after the 2009 irrigation season commenced, the experiments could not be implemented. The PI has had a series of planning meetings with each vineyard cooperator. Each site presents some unique spatial constraints that have been considered. A similar randomized strip-trial design will be employed at each site with three treatment replicates. The Ellis Vineyard (deep soil), Troon Winery and Abacela Winery sites (shallow soil) have drip-irrigated mature spur pruned Cabernet Sauvignon and Tempranillo, respectively. Soil textures range from deep gravelly loam (> 5 feet) to silty clay loam soils (< 3 feet). At each vineyard site in 2009 an ETgage device was installed with a data logger to monitor site ETo and it was found that cumulative site to site variation was less than 8 percent. Pressure bombs have been purchased for use at each site by cooperators and the research team.

In 2010 treatments irrigation will be implemented by using site measured ETo for calculating weekly water application. The vine water requirement (ETc) will be estimated by adjusting full ETo by a vine crop coefficient. The cooperators have all agreed to irrigation treatments as follows: (SD-1) initiate irrigation 6 weeks after budbreak at 70 percent of ETc for the entire season; (RDI-1) initiate irrigation 6 weeks after budbreak at 70 percent ETc until fruit set, then 35 percent ETc until harvest; (SD-2) no irrigation until fruit set, then 35 percent ETc until harvest; and (RDI-2) no irrigation until fruit set, then 35 percent ETc until veraison, and 70 percent ETc veraison to harvest. Cooperators and researchers will rely on careful monitoring of vine water status in the SD-2 treatments to prevent damaging water stress. If vine water status

approaches -1.5 to -1.6 MPa in this treatment, irrigation will be adjusted to 50 percent deficit ET_c.

The PI has met with a regional research committee of experienced growers and winery owners at all stages of project development and will continue during this multi-season project. This research builds upon a vineyard irrigation monitoring and training project that is preparing a knowledge, experience, and practitioner base for growers in the application of ET-based practices. During 2009 all cooperating vineyard managers have been trained to implement the irrigation treatments utilizing site measured ET_o, crop coefficient (K_c), and a spreadsheet irrigation calculator. The PI has made a cooperative agreement with Dr. Steven Petrovic of the Department of Chemistry at Southern Oregon University to utilize his lab's capability to perform the full suite of berry chemical composition required. The PI will be hiring one of Dr. Petrovic's senior students, a biochemistry major who will provide field and laboratory support to the project as her capstone research project. Dr. Petrovic has previously worked with Dr. James Kennedy, formerly in OSU Food Science, and will work with Dr. Osborne to provide a viable alternative to contracting private analytical services.

Early 2010 season weather has not been typical nor favorable for normal vine development, and at most sites soil moisture content is still quite high. It is probable that some changes will have to be made to irrigation treatment protocols, specifically the time for initiation of first irrigation.

Objective(s) of Proposed Research or Outreach Project:

Growers and wineries in Southern Oregon regions strive for consistent production of high quality fruit and wines. Experienced growers delay irrigation until vine shoot growth slows, however after irrigation is initiated most growers continue to rely on qualitative vine indicators and irrigation schedules can vary widely. Therefore deficit irrigation practice may not be precise as it is generally implemented based on the intuition and experience of vineyard managers. This is an industry conceived and supported project that is the first formal research and demonstration in the region that examines the interaction of different deficit irrigation strategies, soil types, and crop levels on growth, berry development and composition of two important winegrape varieties.

Project objectives are as follows:

- Establish multi-season, replicated irrigation and crop level experiments in existing commercial vineyards in warm season growing sites with mature Cabernet Sauvignon and Tempranillo vines grown in soils with lower (< 4.5 in.) and higher (>7.0 in.) plant available water capacities. Implement multi-season experiments that contrast four irrigation strategies (sustained deficit and regulated deficit) and crop level for their impact on vine growth and development, nutrition, yield and berry composition. Apply ET_o data collected at each site to adjust irrigation volumes and intervals, while utilizing vine water status and soil moisture measurements to monitor impacts of treatments
- Assess vine growth and development parameters, including nutritional testing at key phenological stages. Collect sequential fruit samples from just after veraison to harvest to assess changes in berry size, weight, and chemical composition. Apply appropriate statistical tests to determine annual and multi-year vine and fruit responses to irrigation treatments.

- In year three (2012) and beyond, assemble and train a panel of growers and winemakers to assess harvested fruit from experiments by employing a berry sensory assessment method developed in France and Australia (104). Contrast panel evaluation results with the current season's fruit composition analyses.
- Provide the results on an annual basis to growers and winemakers in Southern Oregon and other warm season districts in the state of Oregon region through a variety of outreach instruments. After year 2 and/or 3, communicate experimental results in one or two peer-reviewed articles.

Procedures to Accomplish Objective(s):

1. Establish multi-season, replicated irrigation and crop level experiments in vineyards

As funding was not awarded until well after the 2009 irrigation season commenced, no experiments were implemented. The PI has had a series of planning meetings at each vineyard site. Each site presents some unique spatial constraints that have been considered. A similar randomized strip-trial design will be employed at each site with five treatment replicates. The Ellis Vineyard (deep soil), Troon Winery and Abacela Winery (shallow soil), sites have drip-irrigated mature spur pruned Cabernet Sauvignon and Tempranillo. Soil textures range from deep gravelly loam (> 5 feet) to silty clay loam soils (< 3 feet). Each irrigation treatment will be established by modifying drip systems with shut-off valves. At each vineyard site in 2009 an ETgauge device was installed with a data logger to monitor site ETo. Prior to bloom in 2010, soil moisture access tubes will be installed in three replicate plots of each treatment for routine measurements with a capacitance probe.

The cumulative ETo at the three sites for the period 15 May to 5 October 2009 (Table 1) were relatively similar, although the interactive factors of temperature, light, humidity, and wind speed may differ.

Table 1. Cumulative 2009 season ETo at the three experiment sites

	Abacela	Troon	Ellis
ETo (inches)	28.30	28.68	29.89

2. Implement multi-season experiments that contrast four irrigation strategies and crop level

As noted above the award date for funds did not allow implementation of the first season's experiments. In 2010 irrigation treatments will be implemented by using site measured ETo for calculating weekly water application. The vine water requirement (ETc) will be estimated by adjusting full ETo by a vine crop coefficient. It has been determined that due to structure of a grapevine canopy, light interception as measured by the amount of shade cast on the ground, is a more important determinant of vine water use and the crop coefficient than total leaf area or leaf area index. Cooperators and researchers will make weekly estimates of canopy shaded ground percentages at solar noon to estimate full vine water (Kc). The full canopy crop coefficients and daily crop water requirement are then estimated by:

[1] Crop Coefficient (K_c) = Shaded ground x 0.017

[2] Crop water req. (ET_c) = $K_c \times ET_o$

Irrigation treatment protocols were initially conceived to be as follows: (SD-1) initiate irrigation 6 weeks after budbreak at 70 percent of ET_c for the entire season; (RDI-1) initiate irrigation 6 weeks after budbreak at 70 percent ET_c until fruit set, then 35 percent ET_c until harvest; (SD-2) no irrigation until fruit set, then 35 percent ET_c until harvest; and (RDI-2) no irrigation until fruit set, then 35 percent ET_c until veraison, and 70 percent ET_c veraison to harvest. However, early season conditions have been significantly cooler and wetter than normal. Vine development is late and slow, while soil moisture content is higher than normal. Therefore it is probable that treatment protocol, specifically time for initiation of irrigation will have to be adjusted.

Growers will apply standard cultural practices (e.g. shoot thinning, hedging), but following fruit set all replicate plots will be split into cluster thinning treatments. Cluster thinning will adjust the crop at two target yields per vine. A plant pressure bomb will be used for monitoring of mid-day leaf water potential (vine water status) to assess treatment impacts on vine water status from 6 weeks following budbreak until leaf fall. Cooperators and researchers will rely on careful monitoring of vine water status in the SD-2 treatments to prevent damaging water stress. If vine water status approaches -1.5 to -1.6 MPa in this treatment, irrigation will be adjusted to 50 percent deficit ET_c .

3. Collect vine and fruit samples at key growth stages.

In 2010, commencing after veraison, sequential fruit samples will be collected until harvest to assess changes in berry size, weight, and chemical composition. After veraison, Brix, pH, and titratable acidity (TA) will be assessed in all treatment replicates (irrigation x crop level) at the lab at the Research Center on bi-weekly 50 berry samples. At harvest yield per vine will be determined and a 100 berry sample will be collected from each cluster thinned replicate to determine average diameter and weight, while a 100 berry sample will be collected for berry juice analysis by Dr. Steven Petrovic's (S. Oregon University, Department of Chemistry) laboratory. In 2010 and 2011 berry composition will be characterized based on juice analysis for: Brix, fermentable sugars (glucose + fructose), pH, TA, ammonia-N, alpha-amino acids (YAN = ammonia + amino), tartaric and malic acids, potassium, color, total and polymeric anthocyanins, total tannins, and catechin. With additional funding for subsequent seasons additional assays of berry skin composition will include total anthocyanins, polymeric anthocyanins, flavanols, catechin, and proanthocyanids.

After the vine grand growth stage and prior to canopy hedging, average vine shoot length will be determined each season. Leaf blade samples will be collected in 2010 at veraison for complete nutrient analysis and to establish a nutritional status baseline for subsequent seasons. During the dormant season pruning weights will be determined on a per vine basis for estimates of crop loads. Appropriate statistical tests will be applied to determine annual and multi-year vine and fruit responses to irrigation treatments both within and between sites.

4. Year 2012 and beyond, conduct berry sensory evaluation with growers and winemakers

Assemble and train a volunteer panel in the berry sensory assessment methodology developed and practiced in France and Australia. The method is a tool to assess the characteristics of winegrapes for their degree of maturity and their potential suitability for specific winemaking styles. The methodology includes examination of fresh berries according to twenty standards for

stems, skins, pulp and seeds on a four point scoring scale. This qualitative method is designed to be complementary to other objective measures of berry composition. Rating scores from panel evaluations will be contrasted with results from the current season’s berry juice and skin composition analyses.

5. Communicate the research results through a variety of outreach instruments.

Provide the results on an annual basis to growers and winemakers in Southern Oregon in formal program presentations, field events, reports and newsletter summaries. Present annual project results to growers from other warm season districts in Oregon at state-wide meetings, in newsletter, and during field visits. After 2011, disseminate experimental results in one or two peer-reviewed articles.

Timetable for Project: As the annual funding cycles are not concurrent with the Oregon growing season, work in 2009 was limited to establishment of experimental blocks, design of irrigation treatment protocols and clarification of cooperator and PI responsibilities. In April of 2010 the plots will be established, irrigation systems tested, and final planning completed with each cooperator. .

Task	2010										2011	
	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
1												
2												
3												
4												
5												

Present Outlook and Estimated Success in Accomplishing Objective(s): This project concept has been conceived by interested growers in the Southern Oregon region and is intended to be as long as a five year study, contingent on future funding. Members of the industry have consistently indicated that this is a priority research, demonstration, and training need and, therefore there is excellent support within the industry. This research builds upon a vineyard irrigation monitoring and training project that is preparing a knowledge and experience base for growers in the application of ET-based practices. During 2009 all cooperating vineyard managers have been prepared to implement the irrigation treatments utilizing site measured ETo. The PI has finalized agreements with Dr. Steven Petrovic in the Department of Chemistry at Southern Oregon University to use his lab’s capability to perform the full suite of berry chemical composition required. Dr. Petrovic and the PI will be supervising one of his senior capstone students who is currently doing a literature review on analytical methods, while also being trained in the appropriate methods and equipment that will be employed.

Outreach and Education: The PI is currently an Extension Viticulture Advisor in the Southern Oregon region and collaborates with the Rogue Valley Winegrowers Association, Josephine and Douglas County OSU Extension to provide classroom and one-to-one educational and training opportunities for winegrape growers. As the project matures, the PI will seek opportunities to have this work presented to growers in other winegrape regions and at other statewide forums. Within the Southern Oregon region, the PI will have numerous opportunities to extend results to other interested growers. After the first two or three seasons, one or two peer-reviewed articles would be submitted to appropriate research journals

Funding Status

The PI will continue to seek additional funding sources, to expand the fruit sampling and testing, and berry sensory assessment components in year three and beyond and bring an additional vineyard site from another warm season district in Oregon.

Outside Presentations of Research

1. An overview presentation of the project objectives and methods was presented to growers who attended the 2009 Grape Day in Douglas organized by the OSU Viticulture Program.
2. A presentation was made to the Annual Meeting of the Rogue Valley Winegrowers Association (RVWA) on 30 January 2010.
3. An overview presentation of the project objectives and methods was presented to growers participating in the Rogue Region Workforce Training Program on irrigation on 18 May 2010.
4. A project presentation will be made during the 2010 Southern Oregon Vineyard tour.
5. A project summary presentation with first season results will be offered in a joint OSU and RVWA program in winter 2011.