Annual Report

July 1, 2014 – June 30, 2015

Viticulture and Enology programs for the Colorado Wine Industry

PRINCIPAL INVESTIGATOR

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COLLABORATING INSTITUTIONS

- Colorado Department of Agriculture
- The Colorado Wine Industry Development Board
- Colorado State University

Summary

This report summarizes the work performed during the period 1 July 2014 to 30 June 2015. As such, it covers the latter part of the 2014 growing season and the start of the 2015 growing season. Many of the projects reported herein are long-term, and are continuing beyond the reporting date of 30 June 2015.

The majority of vineyards in Colorado, including our research vineyards, sustained substantial cold damage from an extreme cold event in early December 2013. Consequently, most of the work during the 2014 growing season focused on retraining of cold-damaged vines. Most of the seasonal vineyard work has been performed by student interns (from the Viticulture & Enology program at CSU) and CSU staff at WCRC. New studies on cover crop and irrigation management, methods to increase bud cold hardiness, and evaluation of cold-hardy, resistant varieties were initiated in 2013/14 and 2014/15. The winter 2014/15 was very mild, resulting in minimal cold damage to vines. The majority of mature vineyards should produce a good crop in 2015. In fact, the 2015 growing season promises to be the first season with a full crop for a number of research trials that were established since 2008.

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Research Update

I. Cropping reliability

The emphasis in this project is to develop techniques that reduce the risk of crop losses due to cold temperature injuries. Cold temperature injuries include damages caused by winter injury as well as late spring or early autumn frosts and are the MAIN cause for Colorado's low yields.

1. Grape varieties and rootstocks for Colorado

- New variety and clonal trial at Rogers Mesa (Caspari, Menke)
  A new vineyard was planted at the Western Colorado Research Center - Rogers Mesa (WCRC-RM) in the spring of 2004, with additional vines added in the spring of 2005 and 2006. With the exception of a few missing vines, this planting is complete. Genetic backgrounds of the varieties include both cold-hardy, resistant varieties, mainly from the grapevine breeding program from Geneva, NY, and *Vitis vinifera* varieties.
  Once again, in 2014 there was significant vine damage and crop loss due to cold temperature injury to all *Vitis vinifera* varieties except Rkatsiteli. Crop loss was 100 % for Pinot noir, P. Meunier, and Malbec, and >80 % for Dornfelder and Riesling. This was the fourth year in a row with no crop on Pinot noir, P. Meunier, and Malbec. Given the long-term poor performance of those varieties (only one full crop in 10 years with Pinot noir, one in 8 years with Pinot Meunier, and never a crop with Malbec), those vines were removed in the fall of 2014.
  Harvest dates were 1 October (Regent), 8 October (Dornfelder, Geneva Red), 15 October (Traminette, Valvin Muscat), and 24 October 2014 (Chambourcin, Corot noir, Noiret, Riesling, Rkatsiteli). Yields ranged from a low of 0.1 ton/acre for Riesling and Dornfelder to a high of 2.9 ton/acre for Regent. In comparison, data from the 2014 Colorado Grape Grower Survey indicate an average yield of 0.9 ton/acre for Delta County vineyards. Details for the variety trial for 2014 as well as long-term results were presented to the Colorado grape and wine industry at VinCO 2015 in Grand Junction, CO. This updated information is also available at the Viticulture web page:
  http://webdoc.agsci.colostate.edu/aes/wcrc/techbulletins/Grape variety evaluation at Rogers Mesa, 2004-2014.pdf
  Vines were double pruned: long pruning in late April 2015 followed by a second pruning after bud break in late May / early June. Most varieties have set very well and carry too much fruit, and many vines will require crop thinning (to be performed in July/August 2015).

- Multi-state evaluation of wine grape cultivars and clones (Caspari, Menke)
  This is a long-term (2003-2017), multi-state research project that will test the performance of clones of the major global cultivars and of new or previously neglected wine grape cultivars in the different wine grape growing regions within the U.S. The project is a collaboration of more than 20 states. All participating states follow the same experimental protocol. There are two trial sites in Colorado – one at the Western Colorado Research Center – Orchard Mesa (WCRC-OM) and one at WCRC-RM.

2014 Season

Cold injury to *Vitis vinifera* varieties was very high at WCRC-OM following the cold event in December 2013. Most of the work performed during the 2014 season was retraining of cold-injured vines.

At WCRC-RM, cold injury to *Vitis vinifera* varieties caused near 100 % crop loss and most vines needed retraining from the ground up, but cold-hardy, resistant varieties had minimal or no damage. The exception once again was NY 81.0315.17, which had a high percentage of split trunks (as in 2012), and also required retraining.

Marquette (1.77 ton/acre) and MN 1200 (1.33 ton/acre) were harvested on 12 Sep 2014, Aromella (3.06 ton/acre) on 24 Sep 2014, NY 81.0315.17 (0.93 ton/acre) and Vidal (2.54 ton/acre) on 15 October 2014, and Chambourcin (2.11 ton/acre) on 24 October 2014. Grapes have been used for small-scale winemaking at Ram's Point Winery. Details for this trial were presented at VinCO 2015 and have been posted to the Viticulture web page (see link above). Vines were pruned as described above.

2015 Season

Following a very mild 2014/15 winter cold injury was minimal and most varieties will have a full crop in 2015. Many varieties will require crop thinning to avoid over-cropping.

- New cold-hardy, resistant variety trial in the Grand Valley (Caspari, grower cooperator)

  A new variety trial with 12 cold-hardy, resistant varieties was established within a commercial vineyard in the spring of 2014. The trial was set up with a randomized block design with 6 blocks. Vines were planted in late March / early April 2014 by the grower cooperator. Only 7 vines did not take and were replanted in spring 2015. The grower cooperator is responsible for all the viticultural practices except vine training, which was performed by CSU staff and interns. A USB-501 temperature data logger was set up in the vineyard in early October 2014, and data were collected until May 19, 2015. Unfortunately, the data logger malfunctioned and no data is available for the later part of December 2014, as well as January and February 2015. Nevertheless, available data confirm that this is a cold site (hence the removal of cold-tender *Vitis vinifera* varieties and planting of cold-hardy, resistant varieties). Differences in minimum temperature as high as 15 F between the WCRC-OM site and the trial location were observed. Two examples, one from late fall and one from spring, are shown in Fig. 1. A review of data available from the vineyard weather system network (http://www.winecolorado.org/colorado-grape-growing/weather-station-network/) confirm that the weather conditions leading to those large difference were identical: lack of wind at the trial site located on the valley floor leading to cold air settling near the ground, while sufficient wind on the top of Orchard Mesa prohibits this air stratification.

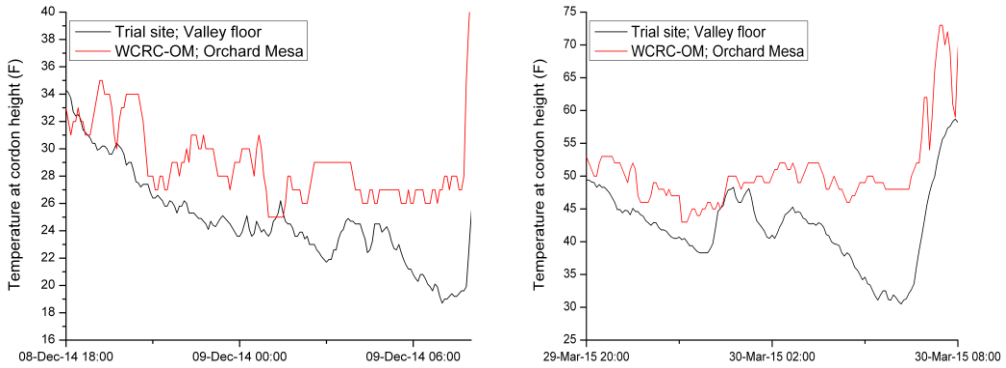

Fig. 1: Air temperature in two vineyard sites in the Grand Valley, Colorado during early December 2014 (left) and late March 2015 (right).

- New cold-hardy, resistant variety trial in Fort Collins (Caspari, Menke, grower cooperator)

  A new variety trial with six cold-hardy, resistant varieties (Aromella, Chambourcin, Frontenac, La Crescent, Marquette, Vignoles) was established in collaboration with a new grower in Fort Collins in the spring of 2013. The trial was set up as a randomized block design with 4 blocks. Vines of two additional cold-hardy, resistant varieties (Noiret, Traminette) were planted in guard rows and at the end of trial rows. Vines were planted in early May 2013 by student volunteers from CSU's viticulture and enology program and the grower cooperator. Two student interns from the CSU program performed most of the vineyard work during the reporting period.

  Two extreme cold temperature events were recorded during the reporting period: -9 F on 12 November, and -22 F on 30 December 2014. Thanks to the volunteer work of Paul Rupp, a former student in our Viticulture & Enology program who resides in Fort Collins, bud wood was collected and buds were evaluated shortly after the November and December events. Figure 2 shows good primary bud survival for Aromella and Frontenac following the November event but very low primary bud survival by Chambourcin, Noiret, and Traminette.

  Although bud evaluations following the December event reveal some minor discrepancies compared to the November samples, the overall trend remains the same: a high percentage survival of primary and secondary buds on Aromella and the Minnesota varieties (Frontenac, La Crescent, Marquette), and low survival on Chambourcin, Noiret, and Traminette. Bud survival of Chambourcin in particular appeared to be much reduced by the -22 F low in December.

  Vines were pruned on Saturday, 9 May 2015, again with the help of student volunteers from CSU's viticulture and enology program. At the time of pruning most varieties were near or already past bud break, and a severe freeze event on 11 May 2015 caused significant cold damage to emerging shoots. As a result, the majority of vines have only a partial or no crop even on the least-damaged varieties (Frontenac, La Crescent, Marquette).

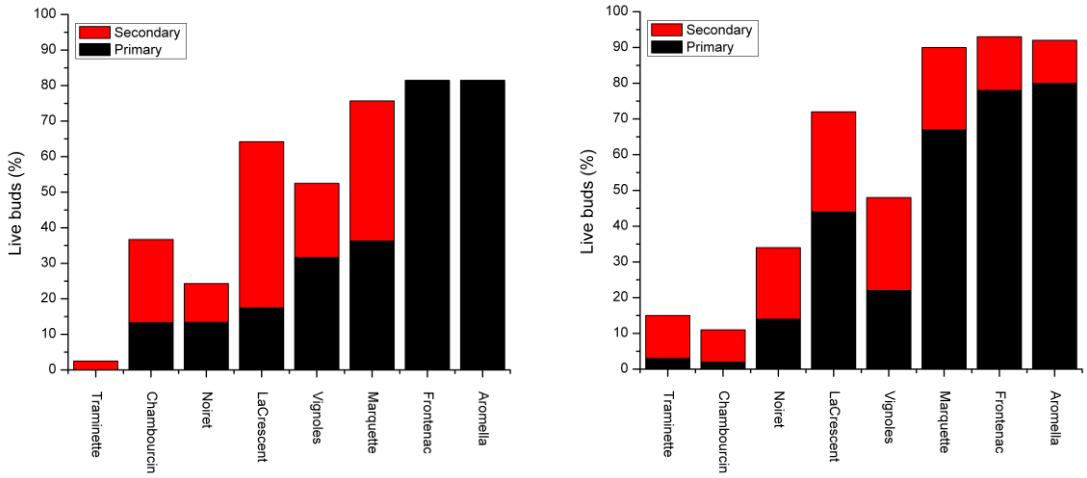

Fig 2.: Primary and secondary bud survival following -9 F on 12 November 2014 (left) and -22 F on 30 December 2014 (right).

- New rootstock trial with Viognier (Caspari)
  The guard rows and end vines for the new variety trial at Orchard Mesa (see "Multi-state evaluation of wine grape cultivars and clones" above) are being used for a rootstock evaluation project with Viognier. Rootstocks being tested include 5BB, 5C, 110R, 1103P, and 140R. Grafted vines are compared to own-rooted vines.
  Similar to the adjacent variety trial there was 100 % crop loss in 2014 and most vines were retrained from the ground. In 2015, vines were double pruned in April / May. The 2015 growing season promises to be the first season with a full crop from this rootstock trial. In fact, most vines carry an excessive crop and will be thinned prior to veraison.

2. Maintaining yield potential

Low yields and large year-to-year fluctuations in yield are characteristic of grape growing in Colorado, even in the Grand Valley AVA. Most times the reasons for low yields are related to cold temperature injury (fall and/or mid-winter and/or spring). In addition to research on grape varieties that may be better suited to the climatic conditions in Colorado (see above), we are also seeking to develop cultural practices that may reduce crop losses from cold injury.

- Characterizing cold hardiness. (Caspari and TBD)
  There are substantial varietal differences in cold hardiness. Understanding the patterns of acclimation, mid-winter hardiness, and deacclimation is a prerequisite to developing strategies that reduce cold injury. Since 2004, we have been testing bud cold hardiness during dormancy of Chardonnay, Syrah, Chambourcin, Rkatsiteli that differ in rate and timing of acclimation and deacclimation, as well as mid-winter hardiness. For the past two years, we have done the first-ever characterization of the seasonal pattern of bud cold hardiness of Aromella. Additional varieties were tested during the 2014/15 dormancy period under the

"Increasing cold hardiness through foliar application of abscisic acid (ABA)" project (see below). Results were made available via our Webpage, and growers are using this information when deciding if freeze/frost protection is needed. Unlike 2013/14, the minimum temperatures during the 2014/15 dormancy period never were low enough to cause bud injury of the varieties we monitor.(Fig. 3).

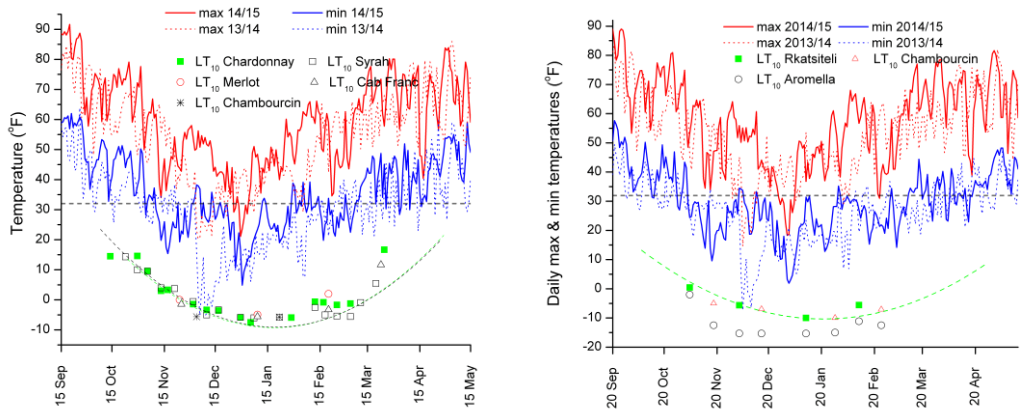

Fig. 3: Daily maximum and minimum temperatures recorded at WCRC-OM (left) and WCRC-RM (right), 2013/14 & 2014/15, and critical temperatures for a 10 % bud kill (LT_{10}). The dashed lines represent predicted values for LT_{10} based on curves fitted to previous years' data.

More information on cold hardiness is available at:
http://aes-wcrc.agsci.colostate.edu/viticulture/cold-hardiness/

- Adjustment of training system to increase grape yield (Caspari, Menke)
  A trial comparing various trellis systems and cane versus spur pruning method was initiated in 2006 using a 1.3-acre block of own-rooted Syrah vines growing at CSU's research vineyard at WCRC-OM.
  There was close to 100 % crop loss in 2014 and most vines were retrained from the ground. Cold injury during dormancy 2014/15 was minimal and vines were double pruned in April / May 2015. Crop load is excessive on many vines, and crop will be adjusted prior to veraison.

- Vineyard floor management - soil and irrigation (Caspari)
  A new experiment was initiated in the fall of 2013 in the Chardonnay block at WCRC-OM (planted in 1992) to evaluate the long-term effects of changes to both irrigation and soil management on vine performance and vine and soil fertility. Shortly after the 2013 harvest, the irrigation system was converted from drip to sprinkler and the soil management in the inter-row area was changed from bare soil to cover crop. Four different cover crops were sown: two different grass-only cover crops; one grass-legume mix; and one legume mix. After establishment of the cover crops one of the grass-only treatments ("Hycrest" crested wheatgrass) was returned to drip irrigation at the start of the 2015 growing season. This latter treatment represents the old status-quo, and is common in many drip irrigated vineyards. The four treatments were randomized with four

replications per treatment. This project is long-term and most of the research is intended to be done by Masters candidates.

The extreme cold temperatures in early Dec 2013 caused significant bud damage to Chardonnay, but unlike most other *Vitis vinifera* varieties only minor trunk damage. Most of the cover crop plots established well, although in a few plots small areas with bare soil and/or weeds needed to be re-sown in the fall of 2014. Late season irrigation was managed to optimize seedling establishment in those areas. Due to the cold damage yields in 2014 were very low and similar for all treatments (Table 1). As we double prune all our vineyards the pruning weights shown in Table 1 are from the first (dormant) pruning in March only. Vines were finished pruned in early May 2015, after bud break.

Table 1: Effect of inter-row soil management and irrigation method on yield and pruning weight of mature Chardonnay vines growing at the Western Colorado Research Center – Orchard Mesa, Grand Junction, CO.

	Yield (kg/vine)	Pruning wt (kg/vine)
Crested wheatgrass / drip	0.85	0.16
Hard fescue / sprinkler	0.77	0.25
Legume mix / sprinkler	0.86	0.15
Grass & Legume mix / sprinkler	0.71	0.14

Soil samples for microbial analysis were taken in June from inter-row areas and immediately under the vines. Samples were taken to Fort Collins where the microbial analysis will be performed in the laboratory of Dr Mary Stromberger, Dept. of Crop and Soil Science. In early June 2015, anionic and cationic resin strips were placed at a depth of 0.1 m in the inter-row area and under the vines. Resin strips remain in-situ for one month, then they are replaced with a fresh set. Once removed and following chemical extraction, the concentration of major plant nutrients will be determined. Results for microbial biomass and nutrient concentration will be presented in future reports.

Cover crops were mowed in early April after the completion of dormant pruning using a flail mower to shred the pruning wood in-situ. Prior to the second mowing, cover crop biomass was determined separately for the East and West inter-row area for each plot in late May (crested wheatgrass; hard fescue; grass & legume mix) and late June (legume mix). A 0.8 m wide and 9.1 m long strip was cut right in the center of the inter-row area using a sickle bar mower set to a height of ~0.1m. Immediately after mowing the cut biomass was collected and weighted. A subsample of ~525 g fresh weight was placed in a paper bag and dried in an oven at 60 ^{o}C to determine dry weight. The remaining cover crop material was returned to the plot and spread out in the area it originated from. The rest of the plots was then mowed with a mulch mower.

Total biomass production, both on a fresh and dry weight basis, was highest for the legume mix and lowest for the crested wheatgrass (Table 2). Note that due to slow growth early in the season the legume mix was mowed approximately one month later than the other three treatments.

Table 2: Effect of type of cover crop and irrigation method on biomass production in the inter-row area in a mature Chardonnay vineyard at the Western Colorado Research Center – Orchard Mesa, Grand Junction, CO. Data is biomass from second mowing in late May or late June 2015.

	Fresh wt (kg/m^2)	Dry wt (kg/m^2)
Crested wheatgrass / drip	0.32	0.15
Hard fescue / sprinkler	0.53	0.22
Legume mix / sprinkler	0.84	0.34
Grass & Legume mix / sprinkler	0.61	0.24

- Increasing cold hardiness through foliar applications of abscisic acid (ABA) (Caspari, Kearney, grower cooperators)

  Research by Zhang and Dami (2012) has shown that late-season foliar applications of abscisic acid (ABA) sprays can lead to an increase in bud cold hardiness of Cabernet Franc. A new trial was established in August 2014 to evaluate the potential of ProTone SG, a new plant growth regulator product containing ABA, to delay bud break and increase bud cold hardiness. The trial was conducted at three sites using four varieties with differences in acclimation and deacclimation, as well as mid-winter hardiness: Chardonnay and Syrah (at WCRC-OM), Cabernet Franc (grower cooperator, site A), and Merlot (grower cooperator, site B). The experimental design is a randomized block with six (WCRC-OM) or three (grower cooperators) treatments, each replicated ten times. Treatments were applied 13 Aug, 2 Sep, and 22 Sep 2014 (WCRC-OM), and 15 Aug and 4 Sep 2014 (sites A and B).

  Controlled freezing tests were conducted in late October and late November 2014, early January, mid February, and late March 2015. With the exception of Merlot, foliar application of ABA appeared to increase bud cold hardiness in October, although the most effective treatments differed between varieties (Table 3).

  Table 3: Effect of foliar application of abscic acid (ABA) on lethal temperature for a 50 % primary bud kill (LT_{50}; F) in late October of 4 grape varieties growing in the Grand Valley, CO. Data from Kearney, 2015.

	Control	V	V20	V40	V + V20	V + V40
Chardonnay	13.2a	9.6b	11.7a	12.1a	9.6b	11.9a
Syrah	11.4a	10.6a	12.1a	8.3b	8.6b	10a
Merlot	14.2	13.6	15.5			
Cab. Franc	13.2a	11.9b	10.5b			

  V, V20, V40: ABA sprayed at veraison, 20, and 40 days after veraison, respectively. V + V20, V + V40: ABA sprayed at veraison with a second application 20 and 40 days after veraison, respectively. Within a row, means followed by the same letter are not significantly different ($p < 0.05$).

  Generally, treatment differences appeared to be less pronounced and tended to be non-significant for the remainder of the dormant season (data not shown). Overall the data from this first year suggest that the main effect of foliar ABA applications is an advancement in cold hardiness in early fall, but no or minimal

effect on mid-winter or spring cold hardiness. Those results are in agreement with published (Zhang and Dami., 2012) as well as unpublished data from Chardonnay and other varieties (Dami, pers. comm.). We will continue to evaluate the most promising ABA treatments during the 2015/16 dormant season.

II. Development of Integrated Wine Grape Production

1. Sustainable resource use

Within an Integrated Production System there is a holistic view of the vineyard environment that requires a sustainable use of vineyard resources, including soil, water, and air. Again, the individual projects listed below are the continuation of our long-term program on the sustainable use of resources.

- Water use of grapevines

  There is a definite lack of understanding of the water needs for grapevines in the Colorado climate. Irrigation inputs vary widely within the Colorado grape industry from too little to grossly excessive watering. An understanding of grapevine water use is a prerequisite for the development of sound irrigation practices.

  We have been monitoring the irrigation volumes applied to our drip and sub-surface drip irrigated vineyards since April 2003. In fall of 2013 the irrigation system in the Chardonnay block was changed from drip to micro-sprinkler. Also, four different cover crops were sown: two different grass-only cover crops; one grass-legume mix; and one legume mix (see vineyard floor management above). Starting in 2014, we are determining the irrigation requirements with different irrigation systems and soil management. An inline flowmeter was installed in one of the sprinkler lines in the spring of 2014 to record the volume of irrigation being applied. Seasonal irrigation input was 19.76", of which 9.33" were applied post-harvest. In comparison, seasonal irrigation inputs were 12-15" in previous years when the block was drip irrigated. It should be noted, however, that the emphasis during the 2014 season was the establishment of the cover crop, which resulted in more frequent irrigations. We continue to monitor the irrigation inputs during the 2015 growing season.

- Water use of young grapevines

  In previous studies using the heat-pulse technique, we determined peak daily water use to be ~8 L per day for mature grapevines trained to VSP and spaced 5' in the row. However, no data are available on vine water use of newly-planted vines throughout the first and second growing season.

  In the spring of 2015, we initiated a study using potted Noiret vines to determine water use by a mass balance approach. Several weeks after bud break all but two shoots were removed from the vines. Each shoot was trained to a bamboo support so that the two shoots created a large "V"-shaped canopy to optimize light interception and minimize mutual shading (Photo 1). In late May vines were fertilized with a slow-release multi-mineral fertilizer (Osmocote Plus). All lateral shoots were removed in late June 2015, and thereafter as they emerged. Growth of the potted vines was equal, if not superior, to second-year vines growing in the research vineyard (Photo 2).


Photo 1 (left): Shoots of a potted Noiret grapevine trained to a "V" trellis.
Photo 2 (right): Second-year Noiret grapevine growing in the research vineyard at the Western Colorado Research Center – Orchard Mesa. Both photos were taken on 1 July 2015. Dimensions of squares on white background are 0.1 m x 0.1 m.

Depending on water requirements, vines were watered two or three times a week until water drained freely from the pots, pot weights were determined when drainage had ceased, and weights determined again prior to the next irrigation. Leaf numbers were determined twice a month so that water use could be related to canopy development.

Some of the pot weight loss that is recorded is due to soil evaporation, and not vine transpiration. The relative contribution of soil evaporation to total water loss is high early in the growing season when vine leaf area is small, but diminishes as leaf area increases. Here we use the term "water use" to encompass both vine transpiration as well as soil evaporation. Mean daily water use under conditions of low evaporative demand (~5 mm/day) and small vine leaf area (~12 leaves per vine) at the end of May 2015 was ~0.1 liter per day. With high evaporative demand (~12.5 mm/day) and increased leaf area (>50 leaves per vine) water use increased to ~2.4 liter per day by the end of June. This study is continuing throughout the 2015 growing season.

III. Grape and wine quality

The emphasis in this project is to continually improve the quality of the grapes, and the wines made from those grapes. Improving the quality of Colorado wines has been a high-priority area for the Colorado Wine Industry Development Board.

- Effect of training system and pruning method on grape yield and wine quality (Caspari, Menke)

  A trial comparing various trellis systems and cane versus spur pruning method was initiated in 2006 using a 1.3-acre block of own-rooted Syrah vines growing at CSU's research vineyard at Orchard Mesa. Trellis systems include Vertical Shoot Positioning (VSP; the industry "standard"), Halbbogen, low and high single wire,

high Sylvoz, Lyre, and Geneva Double Curtain (GDC). Vines with Halbbogen are cane pruned while the remaining vines are cordon-trained and spur pruned (long spur in the case of Sylvoz).

In the spring of 2014, Syrah vines were removed in six rows and replaced with three rows each of Chambourcin and Noiret. A sprinkler irrigation system was installed in the rows with Chambourcin and Noiret (the remainder of the block is irrigated via sub-surface drip).

Work performed during the reporting period included retraining of cold-damaged Syrah vines in 2014; training of newly-planted Chambourcin and Noiret vines; dormant pruning in March / April 2015; some replanting of Chambourcin and Noiret vines in May 2015; and other standard vineyard practices during the early part of the 2015 growing season (e.g. shoot thinning, canopy management, weed control, crop thinning, removal or training of suckers).

TECHNICAL ASSISTANCE

1. Technical assistance to growers

This consists of office consultations, inquiries via phone calls, fax, or e-mails, and field visits addressing a wide range of viticultural aspects. Also, as part of the project "Application of Crop Modeling for Sustainable Grape Production", current weather information from seven vineyard sites is accessible to grape growers and the public via the internet. We are servicing both the software and hardware for this weather station network.

2. Field demonstrations/workshops/tours

We provided several tours of the research vineyard and/or the research facilities to individual growers, visiting scientists, and extension staff. During the Varietal Wine Blending Workshop conducted by Dr. Menke on 16 December 2014 at WCRC-OM we gave an overview of the viticultural characteristics and performances of the cold-hardy, resistant varieties currently being tested at WCRC-RM and the Fort Collins vineyard, as well other cold-hardy varieties included in our previous variety trial at WCRC-OM. In March 2015 we held several grape pruning workshops: on 14 March in Cortez, and on 28 March in Grand Junction. Also, on 16 March 2015 we held a training session for Master Gardeners in Grand Junction.

3. Off-station research and demonstration plots

We know from past experience that the uptake of new research results and new production techniques is fastest when growers are directly involved in their development. One way of involving growers in research is to establish research plots on grower properties. In the spring of 2014 a new variety trial focusing on cold-hardy, resistant varieties was established in a grower's vineyard in the Grand Valley; in the ABA study mentioned above we included two commercial vineyards on Orchard Mesa; we set up three vineyards in the Grand Valley with USB-501 temperature data loggers; and we continued the collaboration on the cold-hardy, resistant variety trial in Fort Collins that was initiated in 2013. The vineyards at WCRC Rogers Mesa also fill a need for demonstration resources in Delta county.

4. Colorado Grape Grower Survey

Colorado State University has conducted this annual survey for over 20 years. Survey forms were sent out in late October. The majority of forms are being sent electronically, although about 1/3 still need to be mailed. Initial result were presented at VinCO in January 2015. The main results of the survey are:

- Approximately 700 ton total grape production; the lowest since 2007
- Average yield of 1.1 ton/acre; the lowest since 1991
- Average price of $1,596/ton
- The average grape price has increased >20 % since 2010
- Average vineyard size is 7.9 acre
- Total vineyard area in Colorado has declined ~10 % over the past 3 years
- Producing vineyard area has declined ~15-20 % over the past 3 years
- With the exception of Cabernet Franc, vineyard areas of the ten most-planted varieties have declined over the past 3 years
- Merlot, Colorado's most-planted variety for ~35 years, may now be ranked #3 in acreage (after Riesling and Cabernet Sauvignon)
- Growers are continuing to remove acreage planted to cold-tender *Vitis vinifera* varieties
- Almost all the vineyard area that is being replanted is replanted with cold-hardy, resistant varieties
- Cold-hardy, resistant varieties now account for >10 % of Colorado's total vineyard area, compared to <2 % only five years ago
- Cold-hardy, resistant varieties are likely to account for ~20 % of Colorado's total vineyard area by the end of 2016
- There is a continued expansion of vineyard area outside of Colorado's main growing areas

The final survey results are available on the Viticulture web page: http://aes-wcrc.agsci.colostate.edu/viticulture/

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