Unified Grant Management for Viticulture and Enology
ANNUAL REPORT 2022-2023 FUNDING CYCLE

OREGON WINE BOARD (OWB)

1. **Summary**:

Project Title: Determining optimal irrigation initiation time

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Delaying irrigation initiation can have many positive direct and indirect effects on grapevine growth and development, and ultimately on fruit and wine quality. The overall objective of this research project is to determine the optimal irrigation initiation time using declining stem water potential thresholds and relating grape yield and berry composition metrices to those thresholds. Our central hypothesis is that growers can substantially delay irrigation initiation time without any negative effects on current or future production.

All treatments were initiated from the end of June to the end of August in a period of 4, 6, or 9 weeks for Jacksonville, Ashland, and Eagle Point, respectively. Total applied water amounts varied between sites, ranging from 55 to 194 mm of applied water per vine. This substantial variation in irrigation initiation timings and amounts between sites was an outcome of different soil types and water holding capacities, different vine age, and climatic conditions of these sites. When compared to 2021 treatment initiations were delayed by an average of 20 days in 2022 due to a cool and wet spring.

Nevertheless, similar responses to treatments were observed across all sites with respect to vine yield, cluster weight, and berry weight. Averaged across all sites, yields ranged from 1.90 to 2.84 kg/vine (3.88 to 5.34 tons/ac); cluster weights from 62 to 84 g/cluster; and berry weights from 0.65 to 0.93 g/berry for the latest (T5) to the earliest (T1) irrigation treatments. By comparison, there were few significant treatment effects on berries per cluster and clusters per vine.

In contrast to yield and yield components, there was negligible impact of irrigation treatments on basic berry composition in any of the sites. Juice Brix, pH, and TA had little to no response to treatments. Finally, berry anthocyanin concentration in 2021 showed a linear response to treatments.

2. **Annual or Final Report**:

Final report

3. **Project Title and UGMVE proposal number**:

Determining optimal irrigation initiation time (2021-2447)

4. **Principal Investigator/Cooperator(s)**:

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5. **Objective(s) and Experiments Conducted to Meet Stated Objective(s)**:

Determine optimal initiation time for irrigation using departures from non-stressed baseline stem water potential values

- *1.1. Pilot phase (end of 2020 growing season)*
  - *1.1.1. Identify grower-collaborator(s) and study site(s)*
  - *1.1.2. Identify data vines for field variability assessment*
  - *1.1.3. Measure vine water status at veraison and harvest*
  - *1.1.4. Determine appropriate experimental design from pilot data*
- *1.2. Experimental phase (2021 and 2022 seasons)*
  - *1.2.1. Layout plots based on predetermined experimental design (year 1)/maintain plots (year 2)*
  - *1.2.2. Measure vine water status regularly from late-May to harvest*
  - *1.2.3. Impose treatments*
  - *1.2.4. Collect agronomic data at harvest*
  - *1.2.5. Correlate agronomic data with initiation times and applied water amounts*

6. **Summary of Major Research Accomplishments and Results by Objective**

A summary of research accomplishments and results for Objectives 1.1 and 1.2.1 can be referenced in the 2021 report. Thus, the following summarizes accomplishments and results for Objectives 1.2.2-5.

1.2.2. Measure vine water status regularly from late-May to harvest

Vine water status measurements began the first week of June at all sites. Measurements occurred weekly until September.

1.2.3. Impose treatments

Treatments were imposed when departures from baseline midday stem water potential (ΔSWP) values reached predefined treatment thresholds. Given the variability in vine age, soil type, and climatic conditions at each vineyard site, imposition dates varied widely across sites (Table 1). For example, all treatments were imposed at the Jacksonville site within a 4-week period from late July to late August, while treatments were imposed at the Eagle Point site over a 9-week period between mid-June and mid-August, and the treatment thresholds at the Ashland site were reached over a 10-week period from mid-June to late-August.

Measured values of ΔSWP for treatment initiation were well-correlated with predefined values (R^2 = 0.99; data not shown), with a few exceptions. Due to poor sampling conditions in early July, T1 initiation at the Ashland sight was missed (Table 1). Significant cloud cover resulted in underestimation of vine stress during midday measurements predating the initiation timing, thus T1 was initiated at same time as T2.

Absolute SWP values at initiation ranged from -0.47 to -1.54 MPa (-4.7 to -15.4 bars) across treatments and sites (Table 1). These values were highly correlated to ΔSWP values, with no difference among sites (data not shown). This result was similar as in 2021, and further indicates that the seasonal pattern of non-stressed baseline SWP was similar across sites, providing evidence that using baseline non-stressed SWP values to normalize SWP values across sites may not be necessary – provided that environmental conditions are similar enough.

Applied water amounts varied by site and, perhaps not surprisingly, were well-correlated with initiation dates such that earlier the initiation, the more water was applied (Table 1). Applied water amounts ranged from 77 to 194 mm at Eagle Point, 59 to 100 mm at Jacksonville, and 55 to 199 mm at Ashland.

Notably, the Eagle Point site experienced significant bird damage in 2022. Blocks 5-8 experienced the highest damage as they were nearest to the vineyard edge. Due to this damage the replicate numbers were reduced such that: T1=5, T2=7, T3 = 6, T4=6, T5=4. All other measurements n=8 for the number of replicates.

1.2.4. Collect agronomic data at harvest

Overall, berry weights, cluster weights, and subsequent yields were reduced linearly with increased delays in irrigation initiation at each site (Tables 2, 4, and 5). Since berry weight is a primary determinant of cluster weight and yield, its reduction with irrigation delays strongly impacted the other two components. By comparison, clusters per vine and berries per cluster were in general, less responsive to irrigation treatments across sites, whereby treatment response depended more strongly on site (Tables 3 and 6). Clusters per vine were reduced in the latest initiated treatments – T4 and T5 – in Eagle Point and Ashland only. These were the two cane pruned sites, but also were the sites that experienced more severe water deficits earlier in the season. Berries per cluster response to treatments varied strongly as a function of site, highlighting the strong local environmental control of berry set.

Primary berry chemistry at harvest showed little response to irrigation treatments compared to yield and yield components (Tables 7, 8, and 9). Brix response was slightly variable across sites, but in general the range across treatments was low. Delayed irrigation reduced Brix in Ashland, while it increased Brix in Jacksonville, and had no impact in Eagle Point (Table 7). When computed across sites, Brix was slightly decreased in T5 compared to the T1, but showed no response in the other treatments. Likewise, irrigation treatments did not strongly impact juice pH and TA when computed within or across sites.

Berry anthocyanin concentrations varied across sites, but showed a positive trend with delayed irrigation, plateauing at T4 (Table 10). Nevertheless, the overall range in anthocyanin concentrations across treatments was relatively low. Pruning weights collected prior to the 2022 growing season showed a slight decrease with delay of irrigation initiation, though the range of treatment averages was low (Table 11).

1.2.5. Correlate agronomic data with initiation times and applied water amounts

Figures 1, 2, and 3 show responses of yield, total soluble solids (TSS), and skin anthocyanins in response to initiation SWP over two years (2021 only for anthocyanins). For yield and TSS, data are shown in absolute values and relative to the control.

The linear response of yield to initiation SWP (Fig. 1) in both years indicates that yield is optimized at initiation SWP values indicative of well-watered vines (i.e., > -0.8 MPa or -8 bars). The response was stronger in 2022 compared to 2021, likely due to carryover effects on bud number and fruitfulness, but variability was low in each year (R^2 = 0.88-0.95). Nevertheless, the data show that from earliest initiation SWP (-0.69 to -0.75 MPa or -6.9 to -7.5 bar), yield declined by 3 to 4% for every 0.1 MPa (1.0 bar) further delay in initiation, resulting in a ~30% yield loss at latest initiation.

In contrast, TSS responded quadratically but weakly in each year, and was optimized at initiation SWP of approximately -1.0 MPa or -10 bar (Fig. 2). There was a slight increase in TSS with initiation delays beyond the control treatment, followed by a decline. Nevertheless, variability was high (R^2 = 0.43-0.56) over the two years, and the range was low across treatments (0.9-1.0 Brix) in each year. Thus, increased delays in irrigation initiation to optimize TSS by < 0.3 Brix would result in a yield loss of 7-13%. To maximize yield, irrigation should be initiated early – before vines are stressed – with a resulting minor cost in Brix. On the other hand, though Brix values may remain stable with as much as 36% reduction in applied water, we observed a 22% reduction in yield.

Finally, skin anthocyanins responded strongly and linearly to increased delays in initiation SWP in 2021 (Fig. 3). They were lowest in the control treatment and increased by 1.3% for every 0.1 MPa or 1.0 bar of delay in irrigation initiation. Thus, under the conditions of this study, increasing anthocyanins by 8-9% would result in a yield loss of 27%.

7. **Outside Presentations of Research**:

Preliminary results from this study were presented to the industry during the Southern Oregon Grape Day in March 2022 and during the OWRI Grape Day in April 2022. In addition, an oral presentation was delivered to an international audience of grape and wine scientists at the TerClim 2022 conference in Bordeaux, France in July 2022.

8. **Research Success Statements**:

The main research successes are the near ideal execution of irrigation treatments at each experimental vineyard site for two consecutive years, and subsequent consistency in vine and crop responses to them. Essentially, the experiment went according to plan in both the first and second years. Though some final data are yet to be collected (e.g., fruit phenolics for 2022), vineyards have been pruned and plots will receive further regular maintenance prior to budbreak in 2023. Laboratory staff are well-trained in all experimental procedures and prepared for the third growing season. Continued funding support has also been secured from the Oregon Department of Agriculture and the Northwest Center for Small Fruits Research to continue field trials through the 2024 growing season and also support winemaking and wine chemical and sensory analyses.

9. **Funds Status**:

Since the last report, $20,554.99 has been spent as follows: $19,132.53 has been spent on salary and OPE, $1,227.46 on supplies/materials/equipment maintenance, and $195 on travel. For the previous year salary consisted of 93% of total expenses and the ongoing data collection of pruning weights and fruit phenolics will primarily fall into this category.

Tables

Table 1
Dates of treatment imposition, ΔSWP, SWP, and total applied water amounts for each irrigation treatment across all three sites in 2022.

Variable	Treatment	Eagle Point	Jacksonville	Ashland
Date of imposition (MM/DD)	T1	06/17	07/27	07/14
	T2	07/07	08/03	07/14
	T3	07/15	08/10	07/28
	T4	07/29	08/17	08/11
	T5	08/19	08/24	08/24
ΔSWP (-MPa)	T1	0.13	0.17	0.48
	T2	0.32	0.54	0.46
	T3	0.67	0.58	0.64
	T4	0.83	0.87	0.80
	T5	1.04	1.12	0.81
SWP (-MPa)	T1	0.47	0.73	0.87
	T2	0.71	1.00	0.92
	T3	1.14	1.05	1.22
	T4	1.42	1.33	1.23
	T5	1.52	1.54	1.30
Applied water (mm)	T1	194	100	191
	T2	166	88	191
	T3	151	78	158
	T4	122	69	126
	T5	77	59	55

Table 2
Response of yield (kg/vine) at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*). Multiply data by 1.72 to obtain values in tons/acre.

Treatment	Eagle Point	Jacksonville	Ashland	All
	----------------------------- *kg/vine* -----------------------------			
T1	1.59	3.45	3.02	2.84
T2	1.27	3.29	3.22	2.65
T3	0.98	3.29	2.80	2.48
T4	0.91	3.07	2.30	2.20
T5	0.86	2.91	1.41	1.90
SE	*0.12*	*0.08*	*0.11*	*0.10*

Table 3
Response of clusters per vine at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Treatment	Eagle Point	Jacksonville	Ashland	All
	----------------------------- *clusters/vine* -----------------------------			
T1	34	34	34	34
T2	31	34	36	34
T3	31	33	35	33
T4	28	34	29	31
T5	28	33	28	30
SE	*1.2*	*0.4*	*0.9*	*0.5*

Table 4
Response of cluster weight at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Treatment	Eagle Point	Jacksonville	Ashland	All
	----------------------------- *g/cluster* -----------------------------			
T1	47	103	89	84
T2	41	96	90	77
T3	32	99	80	73
T4	33	89	81	71
T5	30	88	51	62
SE	*4*	*2*	*3*	*3*

Table 5
Response of berry weight at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Treatment	Eagle Point	Jacksonville	Ashland	All
	----------------------------- *g/berry* -----------------------------			
T1	0.91	0.97	0.92	0.93
T2	0.89	0.93	0.99	0.94
T3	0.74	0.91	0.85	0.84
T4	0.72	0.82	0.79	0.78
T5	0.70	0.72	0.57	0.65
SE	*0.03*	*0.02*	*0.03*	*0.01*

Table 6
Response of berries per cluster at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Treatment	Eagle Point	Jacksonville	Ashland	All
	berries/cluster			
T1	51	109	97	90
T2	45	105	91	82
T3	42	109	93	85
T4	45	110	103	90
T5	40	124	92	94
SE	*3*	*3*	*2*	*3*

Table 7
Response of berry total soluble solids (Brix) at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Irrigation Treatment	Eagle Point	Jacksonville	Ashland	All
	Brix			
T1	23.4	23.0	23.6	23.3
T2	23.1	22.9	23.7	23.2
T3	23.3	22.4	23.5	23.0
T4	23.2	22.8	23.8	23.3
T5	23.2	23.7	20.5	22.3
SE	*0.2*	*0.2*	*0.2*	*0.1*

Table 8
Response of berry juice pH at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Irrigation Treatment	Eagle Point	Jacksonville	Ashland	All
	pH			
T1	3.92	3.47	3.49	3.58
T2	3.93	3.52	3.48	3.63
T3	4.05	3.52	3.46	3.64
T4	3.91	3.46	3.40	3.56
T5	3.88	3.54	3.43	3.56
SE	*0.02*	*0.01*	*0.01*	*0.02*

Table 9
Response of berry juice titratable acidity (g/L) at harvest to irrigation treatments in 2022. Data are means ± one standard error (SE; n = 8*).

Irrigation Treatment	Eagle Point	Jacksonville	Ashland	All
	-----------------------------	*g/L*	-----------------------------	
T1	4.72	6.39	6.23	5.93
T2	4.57	6.54	6.14	5.80
T3	4.31	6.23	5.79	5.55
T4	4.56	6.74	5.59	5.73
T5	4.65	6.33	6.57	6.09
SE	*0.06*	*0.07*	*0.07*	*0.08*

Table 10
Response of berry skin anthocyanins at harvest to irrigation treatments in 2021. Data are means ± one standard error (SE; n = 8).

Irrigation Treatment	Eagle Point	Jacksonville	Ashland	All
	-----------------------------	*mg/g skin DW*	-----------------------------	
T1	18.4	15.8	13.5	15.9
T2	17.9	16.5	14.6	16.3
T3	19.8	16.9	14.6	17.1
T4	19.0	19.6	13.6	17.4
T5	18.0	16.5	17.1	17.2
SE	0.4	0.5	0.4	0.3

Table 11
Response of vine pruning weight to irrigation treatments in 2021. Data are means ± one standard error (SE; n = 8).

Irrigation Treatment	Eagle Point	Jacksonville	Ashland	All
	-----------------------------	*kg/vine*	-----------------------------	
T1	0.26	0.94	0.29	0.50
T2	0.23	0.94	0.37	0.51
T3	0.25	0.94	0.27	0.49
T4	0.22	0.94	0.21	0.45
T5	0.21	0.92	0.23	0.45
SE	*0.01*	*0.02*	*0.02*	*0.03*

Figure 1
Yield as a function of initiation stem water potential (SWP) over two years. Yield data were taken from 'All' column in Table 2 in this report and previous year's (for 2021 data). SWP data were calculated across all sites using values from Table 1 in this report and previous year's (for 2021 data). Yield responses are shown as absolute values (A) and relative to control (B).

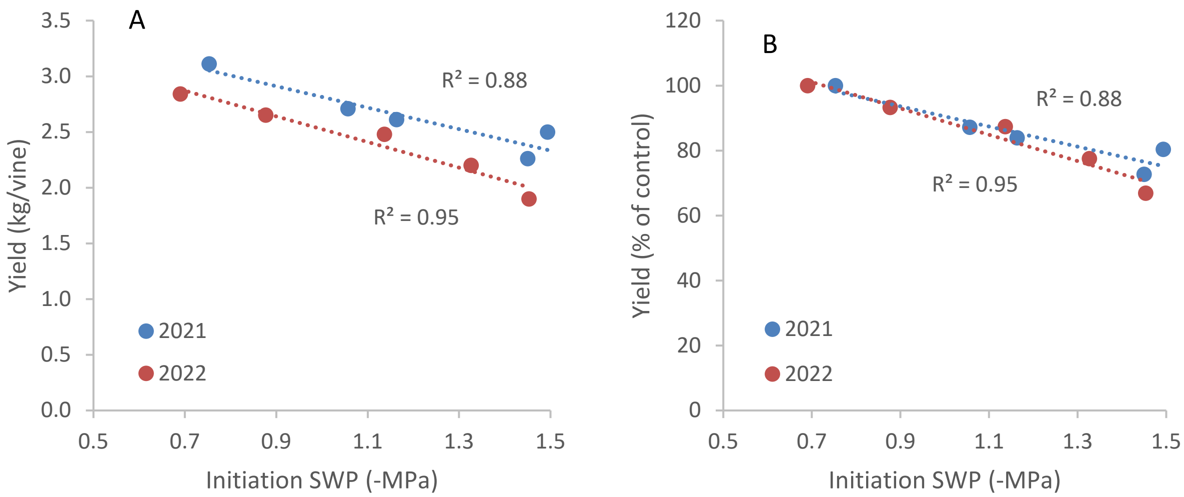

Figure 2
Total soluble solids (TSS; Brix) as a function of initiation stem water potential (SWP) over two years. TSS data were taken from 'All' column in Table 7 in this report and previous year's (for 2021 data). SWP data were calculated across all sites using values from Table 1 in this report and previous year's (for 2021 data). TSS responses are shown as absolute values (A) and relative to control (B).

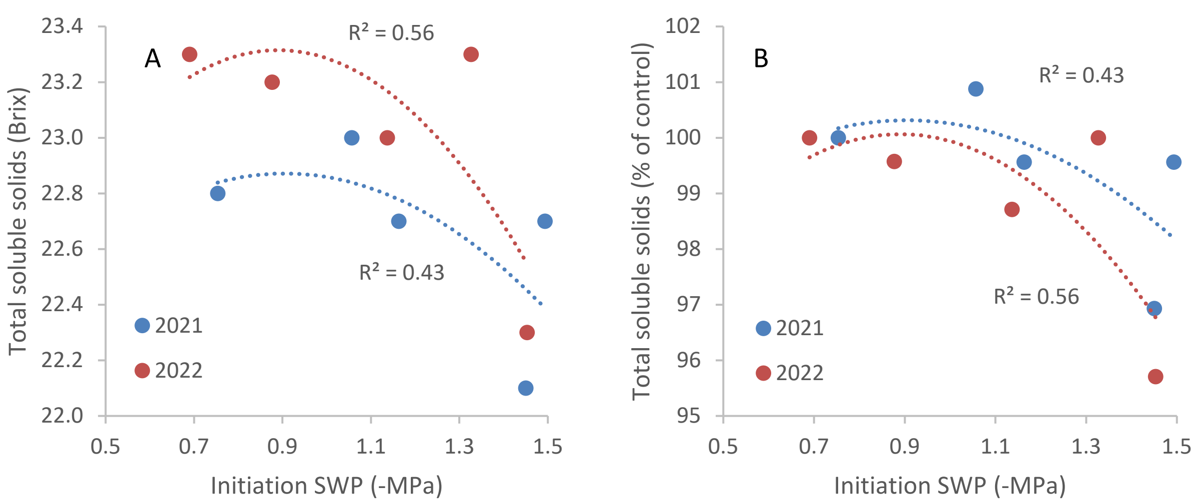

Figure 2
Berry skin anthocyanins as a function of initiation stem water potential (SWP) in 2021. Data were taken from 'All' column in Table 10 in this report. SWP data were calculated across all sites using values from Table 1 in previous year's report. Response is shown relative to control.