VINEYARD: Table of Contents

VINEYARD

This section describes how we manage the vineyard at Chateau Hetsakais

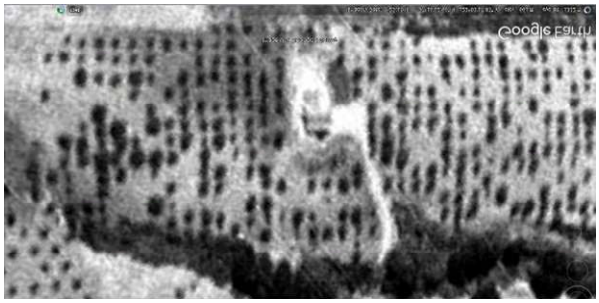
Vineyard Overview

This page provides an overview of the Vineyard section. We cover the history of the vineyard, outline the section, review our practices over the last 25 years and describe what we measure and how we manage with the collected data. A pdf file of the entire section can be found here: 2021-05-07 VINEYARD Section pdf

History

The property has evolved over the last 70 years: It morphed from an orchard to a horse property to a vineyard and, finally, to a vineyard with a winery. These pictures from Google earth provide an aerial view of the evolution

1948 Orchard with house



1991 Hose with pool, garden & horse facilities

2000 First picture showing lower vineyard

2007 Starting construction on the winery

2013 Winery completed

2015 Planting upper vineyard

2020 Latest picture

We acquired the property in 1996 and planted the first vineyard in 1997 in the Lower Field (right in picture). We were new to the area in 1997 and babes-in-the-woods what regards vineyards, so we followed the recommendation of a friend to hire an expert in establishing and maintaining vineyards: Ron Mosely, then at Cinnabar Vineyards & Winery. Ron designed and planted it with Cabernet Sauvignon vines. He also managed the vineyard for the first three years – so we were not very involved at the beginning. In 2007 we decided to build a small winery (to the left of the Lower Vineyard). In 2014 we decided to plant a second vineyard for two reasons. First, the yields in the Lower Field were dropping due to diseases. Second, we wanted to augment our grape choices for blending the Cabernet Sauvignon with Merlot, Cabernet Franc, and Petit Verdot to get more of a Bordeaux style wine. We planted the Upper Field on our own with some consulting support from Ron Mosely.

Outline of the Vineyard Section

This section starts with two pages on how we established the vineyards:

1. **Site Preparation** describes what it takes to prepare the terrain for planting a vineyard
2. **Planting & Replanting** describes the decisions and activities in planting the vines

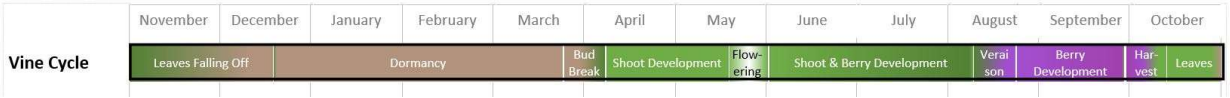
The pages which follow describe the annual tasks in managing a vineyard. We group these tasks into four pages, described in more detail below

3. **Soil** management
4. **Plant** Management
5. **Nutrition** management, and

6. **Pest** management

A final page in this section covers how we monitor the weather and why (**7. Weather** Monitoring)

We orchestrate the vineyard management tasks around the annual cycle of a vine which the following graphic summarizes:



We distinguish between the following steps, starting in November each year:

- Leaves are falling while the vine above ground goes dormant.
- By mid-December, all leaves have dropped, and the plant goes dormant until March. The vines accumulate carbohydrates in the canes, and roots develop further.
- In late March, new buds swell and break out.
- In April through May, new shoots are emerging from the buds.
- In late May, the vine flowers (pollination of grape berries).
- In June, the flowers set to berries, the berries get larges, and shoots grow longer through early August.
- In August, the berries turn from green to red (Veraison), start to soften, and build up sugar. Anthocyanins are replacing chlorophyll in the berries.
- Through late September, the berries ripen, accumulating sugar and tannins.
- In late September / early October, the berries have reached full ripeness and are ready to be harvested.
- In October, the leaves remain, and some turn red.

These pictures illustrate what a single vine looks like going through the year

1 November: Vine without grapes after picking

2 January: Leaves have fallen off

3 Mid-January: Canes pruned halfway

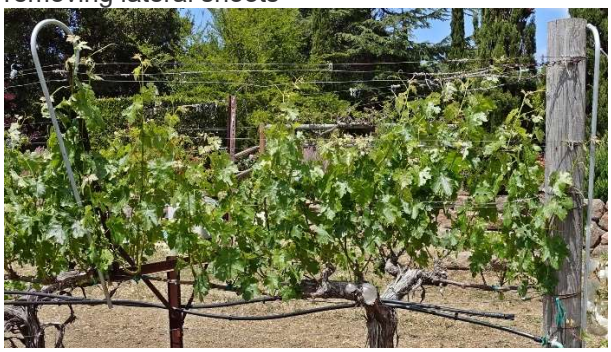
4 Mid-March: Canes pruned down to 2 buds every 6-8 inches

5 Early April: Budbreak – first new growth

6 Late April: growth requires shoot thinning, which reveals Eutrypa infection

7 Early May: front arm cut off due to Eutypa infection

8 Late May: further shoot thinning and start of removing lateral shoots



9 Late June: Shoots have reached target length and are clipped at the top

10 Late July: Veraison started, nets have been put on

11 Mid-August: Veraison progressing

12 October – Getting ready to harvest

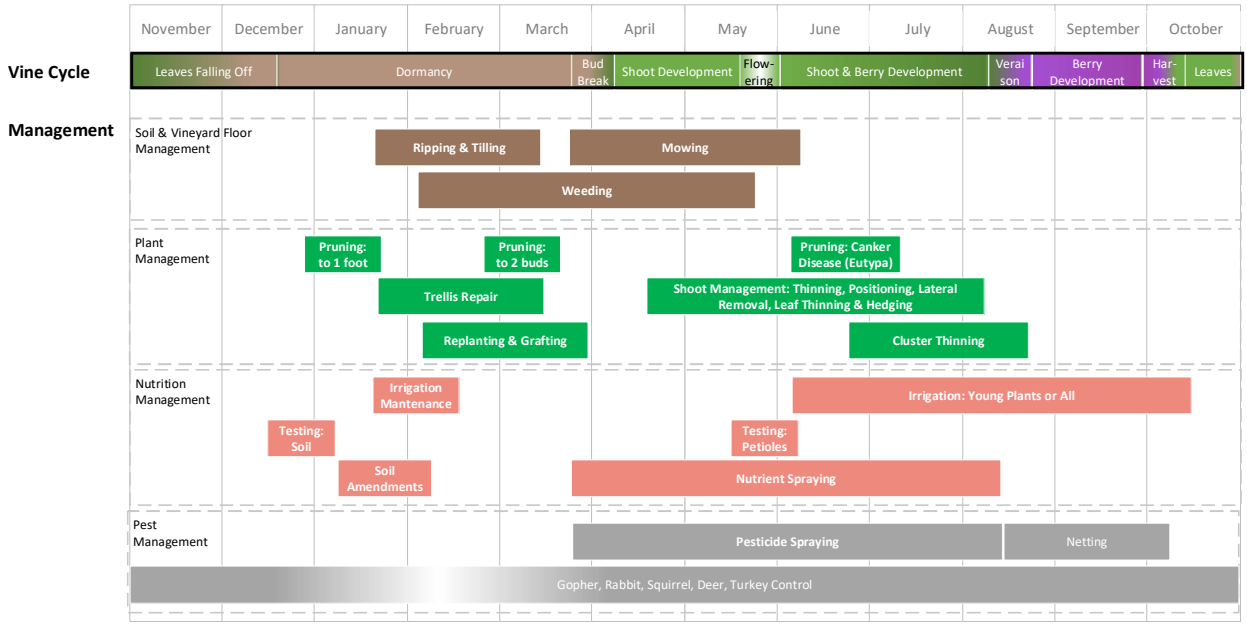
13 November – Leaves are turning

14 December – Leaves have fallen off

In the context of this annual cycle, we divide Vineyard Management into four groups of activities and tasks:

- **Soil & Vineyard Floor Management** involving ripping & tilling, mowing, and weeding
- **Plant Management** involving: pruning, shoot-thinning, hedging, shoot-positioning, trellis repair, lateral removal, leaf-thinning, cluster-thinning, and Replanting & grafting.
- **Nutrition Management** involving soil and foliar testing, soil amendments, foliar sprays, irrigation maintenance, and irrigation.
- **Pest Management**: involving netting to protect berries from birds and insects, spraying fungicides (mostly against mildew), and preventing ground animals (gophers, squirrels, rabbits, deer, coyotes, and turkeys from harming the vines and their roots.

The following chart shows how the listed tasks align time-wise with the annual growth cycle



Management Practices 2000-2018

2000 – 2009 Getting Started: During the first ten years, we moved from outsourced vineyard management to doing everything ourselves.

- The vineyard was planted in 1997 and managed for the first three years by Ron Mosley under contract. We watched the vines grow and organized the picking crew for the first harvest in 2000.
- Starting in 2001, we engaged Rick Anzalone to support and teach us how to manage the vineyard ourselves. In 2002 we applied for an Operator Licence and started reporting the spray activity directly to the Santa Clara County Dept of Agriculture. We dropped the 2002 and 2004 vintages due to mildew, a consequence of not spraying diligently. Until 2004 we sprayed by hand with backpacks and hoses.
- In 2006 we took over all the work in managing the vineyard. We discontinued using herbicides (Roundup) under the vines and started tilling instead. Unfortunately, we did not fight an invasion of gophers which ended up eating the roots of 40+ vines in 2007 & 2008. We continued to keep poor records on our vineyard management practices
- In 2009 we replaced 47 dead vines with new plants. We did more shoot thinning and leaf thinning to reduce mildew. We were far more aggressive in pruning the old vines back to increase grape quality. However, this backfired as we did not protect the large cutting wounds adequately, and the vineyard got heavily infested with Eutypa (“Dead Arm Disease”). Consequently, we had to cut off and regrow most cordons over the next eight years, which reduced crop yield by close to 70%!

The following table summarizes the vineyard practices 2000 – 2009

Vineyard Management outsorced							Vineyard Management inhouse			
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**TASK**	**2006**	**2007**	**2008**	**2009**
managed by ron Mosely	managed by Anzalone					**Fertilizing**				no records
						Replanting				47 CSV 337 on 4453 roots
						Pruning				
						Tilling	rototill	rototill	rototill	rototill
						Wild Life Issues	gophers & deer	gophers & deer	gophers & deer	gophers & deer
						Bud Break (start Date)				
						Shoot Thinning				
						Flowering (start Date)				
						Positioning, Lateral Removeal				
						Eutypa Control	none	none	none	none
						Fruit Set(start Date)				
						Leaf Thinning				
						Bunch thinning	none	none	none	none
						Veraison (mid Date)				
						Grape Thinning	none	none	none	none
						Bird Defense	black nets	black nets	black nets	white nets
						Maturity Assessment	Brix	Brix	Brix	Brix
22-Oct			24-Sep			**Harvest (Date)**	22-Oct	26-Oct	11-Oct	10-Oct
Crew 10: Moore, Goldstein, Ogle, Ferf, Graves, Russell, Page	Anzalone & crew		ourselves		Anzalone & crew	**Harvest Crew**	Crew 10: Mitchell, Morrissey, Terry, Anderson, Hill,			Crew 9: Rossi, Martin, Agarwal, Pashe
0.93 tons	1.96 tons	Abandoned harvest due to mildew damage	1.74 tons	Abandoned harvest due to mildew damage	1.65 tons	**Crop**	1.86 tons	1.75 tons	2.04 tons	2.1 tons, 23.6Brix
all ti Cinabar	all to Clos Tita		all to Clos Tita		all to Clos Tita	**Crop Sale**	all to Clos Tita	all to Clos Tita	all to Clos Tita	0.8 tons to Kathryn Kennedy
						Weather Summary				
	no records		2 Sprays: Thiolux/Rubigan, Thiolux/Ralley		9 sprays: Champ, Thiolux, Kaligreen, Thiolux, Ralley, Thiolux/Ralley, Pristine, Pristine/Ralley	**Spray Program**	9 Sprays Champ/Thiolux, Pristine, Stylet, Pristine, Kaligreen/Rubigan, Kaligreen/Rubigan, Thiolux, Thiolux	12 Sprays: Champ, Thiolux, Kaligreen, Pristine, Thiolux, Thiolux/Ralley, Thiolux/Rubigan, Pristine, Pristine, Stylet, Pristine	8 Sprays: Champ, Thiolux, Pristine, Pristine, Pristine, Stylet, Thiolux, Pristine	6 Sprays: Champ, Thiolux, Thiolux, Pristine, Pristine
						Irrigation				

2010 – 2015: Better data collection & improving practices: During the next six years, 2010 – 2015, we further enhanced our practices. The following table provides detail during this period.

- In 2012 we started to take detailed notes on our vineyard practices. We finally succeeded in keeping the deer out and the gophers under control. We began to remove

all laterals to control canopy growth. In 2012 we switched to pruning with electric shears. We removed most laterals to contain canopy growth, and we thinned the crop to even out maturity. 2013 produced the highest quality fruit.

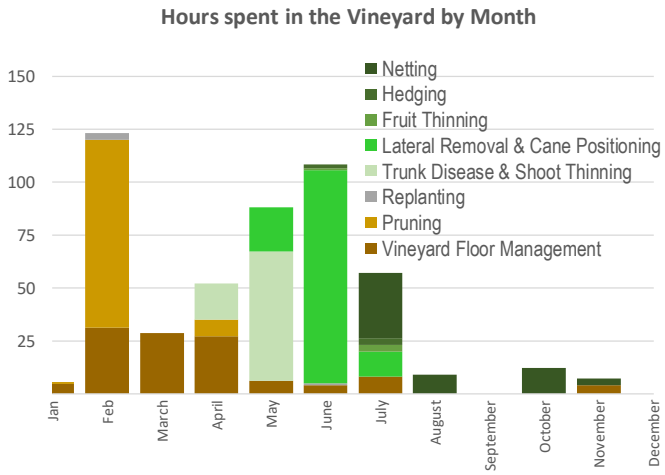
- In 2014 we started pruning in 2 passes to limit further new Eutypa infections, which we continue to fight. We bought another 50 new plants with the idea to replace Eutypa damaged vines, this time Merlot. We also started to monitor berry development during final maturity, measuring Anthocyanins
- In 2015 we started using Vitiseal, a new sealant for cutting wounds against Eutypa and other fungi. The results were very encouraging. Unfortunately, we were distracted with planting the upper vineyard and failed to spray early in the season, so we got significant mildew infections which led to poor fruit set and significant mildew damage.

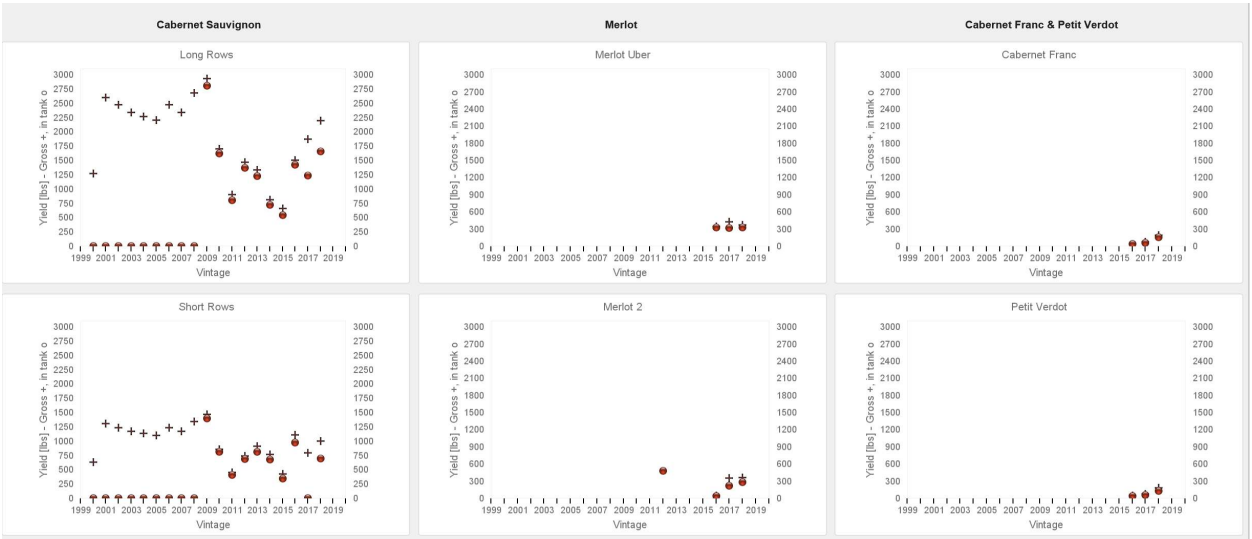
Vineyard Management inhouse

TASK	2010	2011	2012	2013	2014	2015
Fertilizing			12 yrds compost	50 lbs Hydrophyl, 2 sprays VF-11l 20*3,	50 lbs 15*3, 18 yrds horse compost, 2 sprays VF-11	40 yds mushroom compost, 4800lbs Lime, 650lbs PotassiumS, 300lbs Phosphate Bone Meal 13lbs ZincS, 5lbs Sodium Borate
Replanting					50 Merlot Uebervines clone 3 on 110R in pots	77 Cab Sauv, 25 337 on 110R green, 52 337 on 101-14 bare-roots
Pruning	by hand, aggressive	by hand	by hand, soap protect	electric, topsin protect	electric, 2 pass, Feb 20 & Mar 30, Topsin protect	electric, 2 pass, Vitiseal protect
Tilling	rototill	rototill	2 passes	2 passes	3 passes	3 passes
Wild Life Issues	gopher & deer	gophers & deer	gophers	gophers & squirells	(gophers) & squirells	gophers & squirells
Bud Break (start Date)			25-Mar	20-Mar	8-Mar	7-Mar
Shoot Thinning			yes	yes	yes	yes
Flowering (start Date)					20-Apr	4-May
Positioning, Lateral Removeal		limited	many laterals	all laterals removed	all laterals	all laterals
Eutypa Control	none	removed 25% arms	removed 40% of arms	removed 30% arms	removed 30% arms	removed 15% arms
Fruit Set(start Date)					30-Apr	15-May
Leaf Thinning		limited	removed leaves to 4th bud	removed leaves to 3rd bud	removed leaves to 2nd bud	removed leaves to 2nd bud
Bunch thinning	none	none		yes	yes	yes, mostly mildew removal
Veraison (mid Date)			5-Aug	25-Jul	25-Jul	4-Aug
Grape Thinning	none	none	none	green bunches	green bunches	none
Bird Defense	white nets	white nets failed system	green nets	green nets	green row netting + bird caller	green nets
Maturity Assessment	Brix	Brix	Brix & ICV	Brix & ICV	Brix, ICV & Anthos	Brix, ICV & Anthos
Harvest (Date)	20-Oct	4-Nov	7-Oct	28-Sep	11-Oct	26-Sep
Harvest Crew	Crew 11: Daniels, Healy, LePlain, Martin, Rossi, Scanlon, Terry	Crew 7:	Crew: 13 Robins, Muhr, Rossi, Mairose, Smith, Anderson, Gaulthier, Heissel, Fryburger	Crew 16, Robins, Martin, Agarwal, Rossi, Rossi, Mairose, Fryburger, Crosby, Lapinski	Crew of 24 Fenyvesi, Martin, Rossi Sr, Rossi Jr, Crosby, Agarwal, Wong, Steele, Beder, Ogle, vonMeiss, Guldi, Carlitz	Crew of 16 Fenyvesi, Martin, Rossi Sr., Rossi Jr., Crosby, Grant, Chilcoat, St.Pierre, Ogle, Vonderheyden, Guldi
Crop	1.2 tons, 22Brix, 3.5pH	0.6 tons, 21.5Brix	1 ton, 23Brix, 7.9TA, 3.46pH	1.1 ton, 25Brix, 3.45pH	0.85 tons, 24.5Brix, pH 3.55, TA 5.4	0.49 tons, 25 Brix, pH 3.3, TA 8.5
Crop Sale	none	none	none	none	none	none
Weather Summary	late hotspike	rain through May, cool summer	wet winter, dry summer	exceptional	dry winter, warm spring	warm winter, cool spring
Spray Program	4 sprays: Thiolux, Thiolux, Stylet, Thiolux	7 sprays: Kaligreen, Thiolux, Thiolux, Thiolux, Thiolux, Vintre	5 Sprays: Champ/Vintre, Kaligreen/Vintre, Thiolux, Thiolux, Thiolux/Manganese	4 sprays: Ralley/Thiolux, Ralley, Pristine, Thiolux	3 Sprays: Ralley, Stylet, Stylet	5 sprays: Kaligreen, Ralley, Vintre, Microthiol, Pristine
Irrigation					in Jan & Feb	in Jan & June

2016 onwards: managing multiple varietals: In late 2014, we decided to plant a second vineyard in the upper field with vines that complement Cabernet Sauvignon for Bordeau blends: Cabernet Franc, Petit Verdot, and Merlot. We planted in spring 2015. The following five-year period is mostly about further improving the vineyard practices and getting a handle on keeping more valuable records.

- In 2016 we updated the irrigation for the new and weaker plants, and we continued training new arms off the main trunks on Eutypa infested vines. The retraining succeeded beyond expectations. The crop yield rebounded after four years of decline from a low of 1000 lbs in 2015 to over 2400 lbs in 2016. We decided against dropping the second-year fruit in the Upper vineyard as the vines grew faster than expected. We also started to record time spent on each task in a spreadsheet. The graphic on the right shows the first result for 2016





- In 2017-18 we focussed on retraining the new arms in the Eutypa-infested plants in the lower field, and we brought the upper field on stream. The graphic above shows how the Cabernet Sauvignon yields in the lower field continued to rebound from the 2015 lows and how the blocks in the upper field (Merlot, Cabernet Franc, and Petit Verdot) started

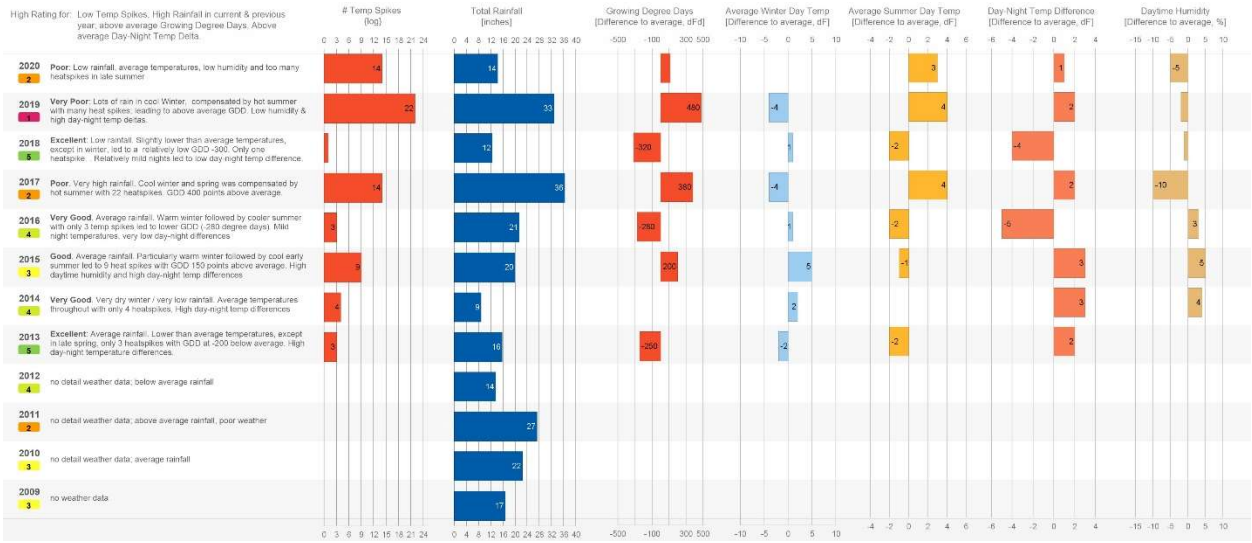
to produce. In 2017, we began tracking activities for the six different vineyard blocks. We realized that we hit a brick wall in data management with Excel and Word. So, 2016 was the last year for comparison.

Lower Field			Upper Field	
2015	**2016**	**TASK**	**2015**	**2016**
40 yds mushroom compost, 4800lbs Lime, 650lbs PotassiumS, 300lbs Phosphate Bone Meal 13lbs ZincS, 5lbs Sodium Borate	none	**Fertilizing**	40cyds mushroom compost, 280lbs Phosphate,360lbs PotassiumS, 575lbs CalciumS, 7lbs ZincS, 3lbs Manganese, 3lbsFeS, 7lbs SBorate	none
77 Cab Sauv, 25 337 on 110R green, 52 337 on 101-14 bare-roots	15 Cab Sauv 337 on 110R in pots form 2015	**(Re)planting**	49 Ueber Merlot 3 on 110R, 125 Merlot 15 on 101-14 br, 52 Pverdot 2 on 110R br, 26 CabFranc 214 0n 101-14 br	3 Merlot 15 on 101-14
electric, 2 pass, Vitiseal protect	by hand, 2 passses Vitiseal protect	**Pruning**	none	back to trunk except Ueber Merlot
3 passes	2 passes	**Tilling**		weeding by hand
gophers & squirells	gophers	**Wild Life Issues**	gophers	gophers & squirells
7-Mar	14-Mar	**Bud Break (start Date)**		13-Mar
yes	yes	**Shoot Thinning**		none
4-May	16-May	**Flowering (start Date)**		16-May
all laterals	all laterals	**Positioning, Lateral Removeal**		none
removed 15% arms	removed 10% of arms	**Eutypa Control**		none
15-May	25-May	**Fruit Set(start Date)**		27-May
removed leaves to 2nd bud	removed leaves to 1st or 2nd bud	**Leaf Thinning**		removed leaves to 1st or 2nd bud
yes, mostly mildew removal	5% on early veraison & mildew	**Bunch thinning**		on weak plants
4-Aug	27-Jul	**Veraison (mid Date)**		27-Jul to 7-Aug
		Grape Thinning		30% on young plant
row nets	row nets	**Bird Defense**		side nets
Brix, ICV & Anthos	Brix, ICV & Anthos	**Maturity Assessment**		Brix, ICV & Anthos
26-Sep	8-Oct	**Harvest (Date)**		15-Sep
Crew of 16 Fenyvesi, Martin, Rossi Sr., Rossi Jr., Crosby, Grant, Chilcoat, St.Pierre, Ogle, Vonderheyden, Guldi	Crew of 16: Rossi, Rossi Jr, Ogle, Martin, Hunyor, Parson, Papp, Robins, Guldimann (T&T)	**Harvest Crew**		Crew of 4: Anita Page, Nick Vonderheyden, Guldimanns
0.49 tons, 25 Brix, pH 3.3, TA 8.5	1.28 tons, 24 Brix, pH 3.3, TA 7.75	**Crop**		0.2 tons, 25 Brix, pH 3.5, TA 6
none	none	**Crop Sale**		none
warm winter, cool spring	cooler year with heat spikes	**Weather Summary**		cooler year with heat spikes
5 sprays: Kaligreen, Ralley, Vintre, Microthiol, Pristine	4 sprays: Pristine, Ralley, Vintre & Pristine	**Spray Program**		4 sprays: Pristine, Ralley, Vintre & Pristine
in Jan & June	new plants: weekly	**Irrigation**	weekly all plants	weak plants: weekly

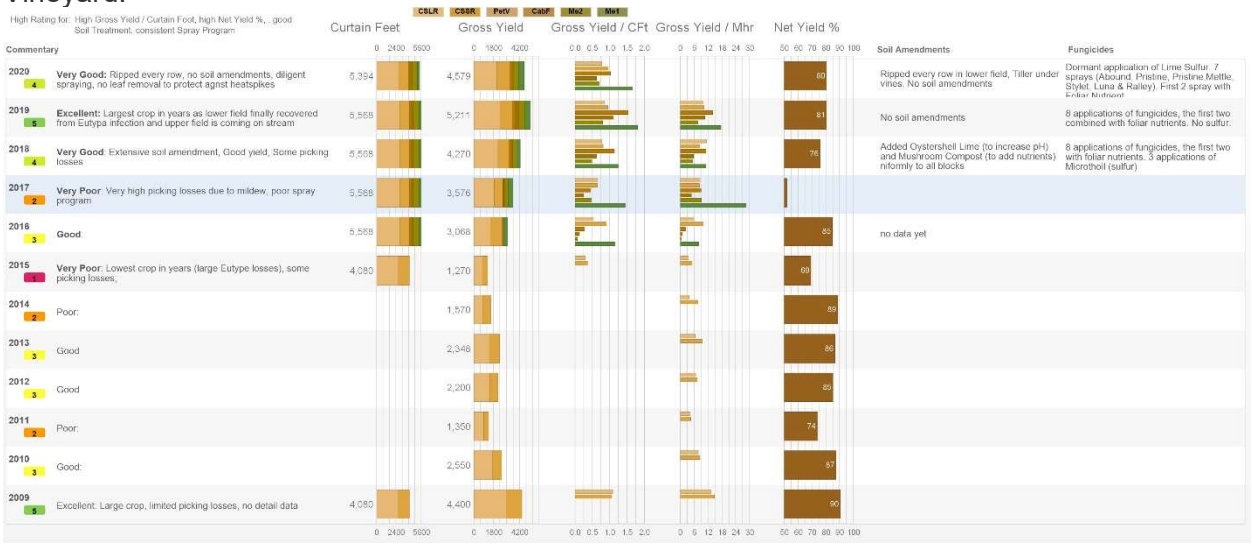
- In 2018 – 21 we focused on improving the spray programs and changed the netting from annually installed full covers to permanent side-nettings. We expanded the database and backfilled it with historical data.

The following screenshots compare the weather conditions, the vineyard activities, the berry maturation, and the harvest yields for the 11 vintages since 2009:

Weather conditions:



Vineyard:



Berry Maturation:

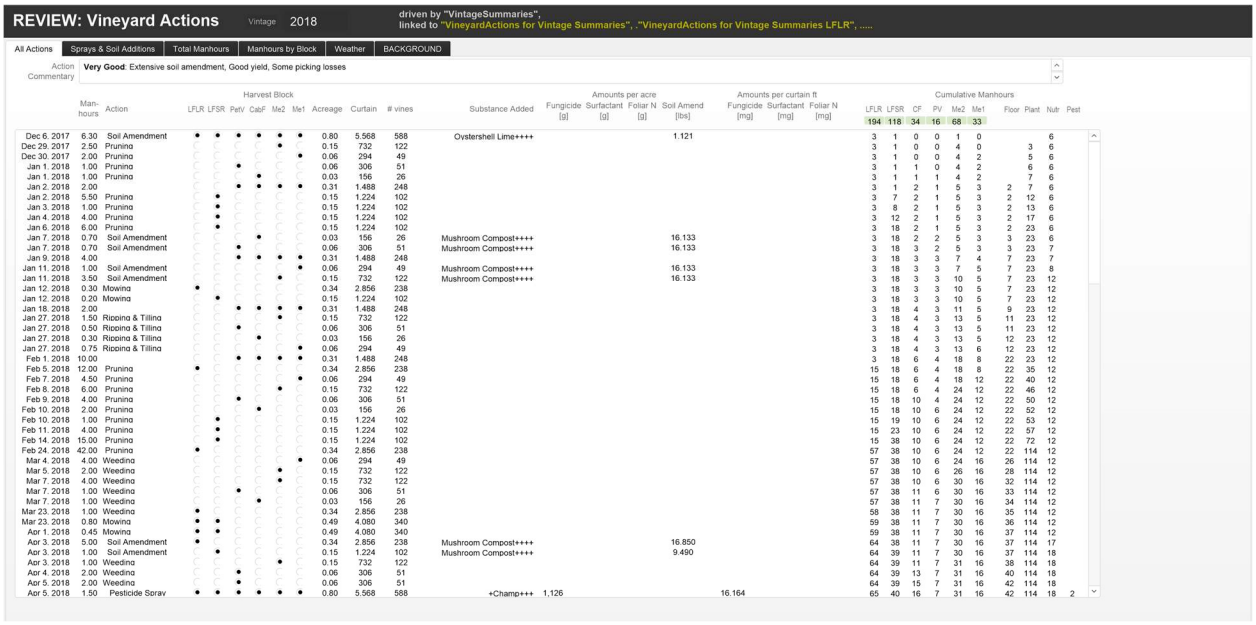
Harvest:

Data Management

Managing a vineyard of our size is much more based on qualitative observations than quantitative measurements. You monitor whether a plant looks and feels OK rather than measure data and optimize results. We recorded our actions in word documents and tables through 2016 and experienced increasing challenges in making practical use of the records. So,

in 2018 we started to track our activities in the database. It will take some years to see the benefits of this effort

Following are screenshots of the “REVIEW: Vineyard Actions” – Layout. The first lists all the individual activities of 2018, the substances added, and the manhours spent on each (note the list is longer than the screenshot reveals). The second provides an overview of the “substances added,” the Sprays and Soil Amendments. The third shows the cumulation of manhours by vineyard block and type of activity, and the last screenshot summarizes the weather conditions.

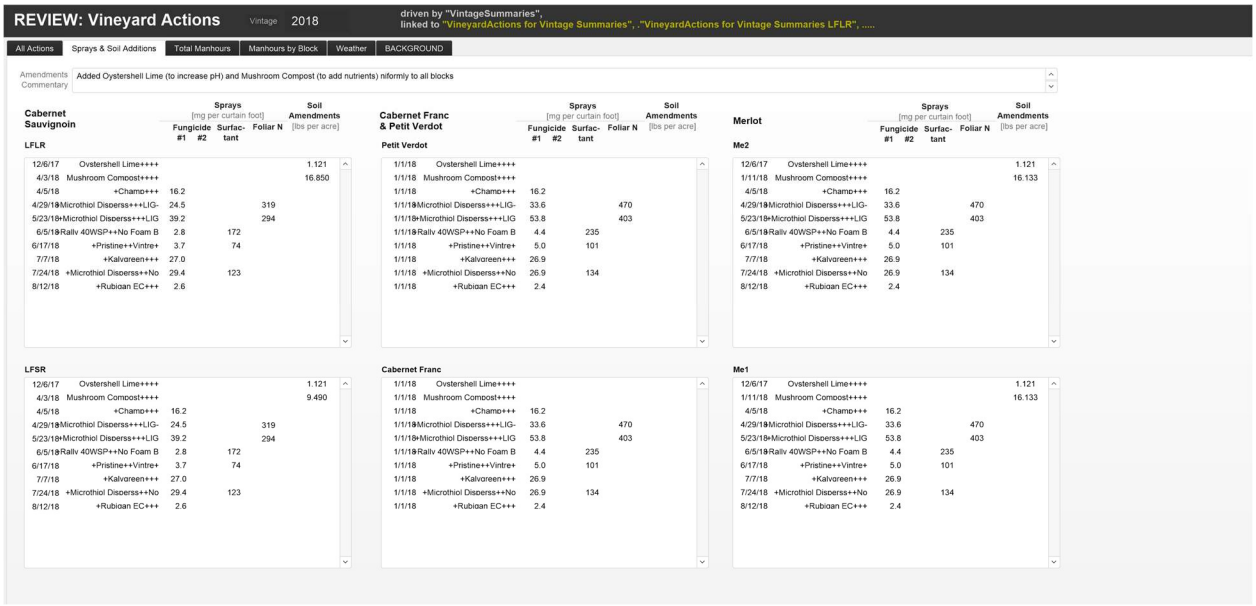


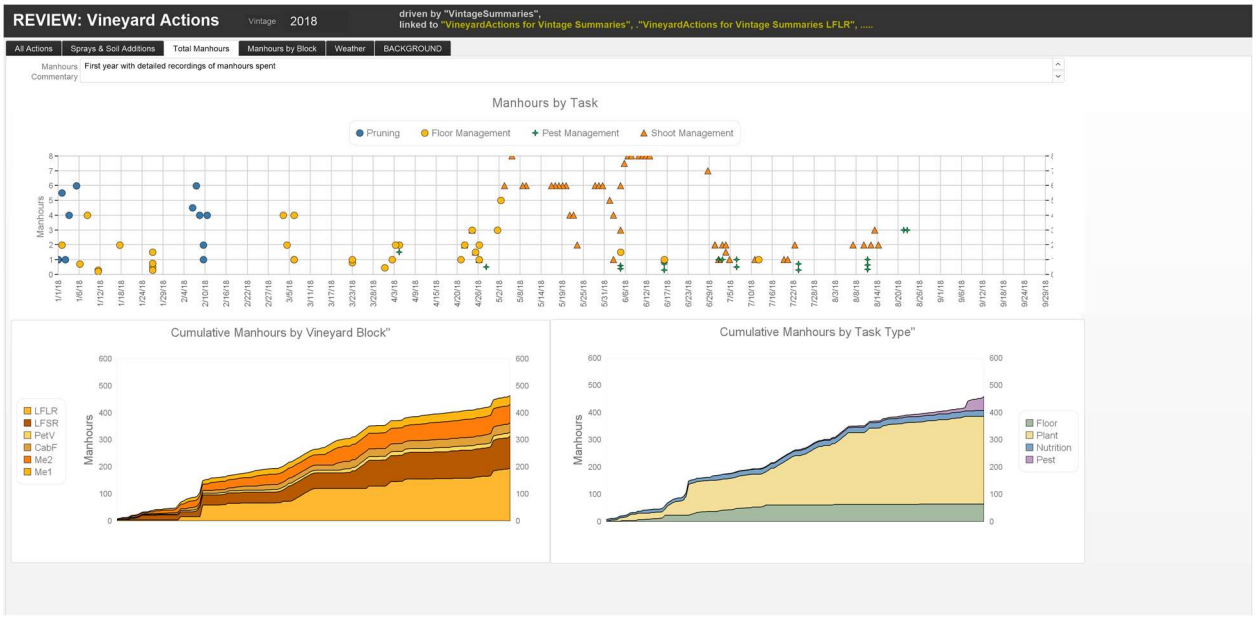
REVIEW: Vineyard Actions Vintage 2018 — driven by "VintageSummaries", linked to "VineyardActions for Vintage Summaries", .."VineyardActions for Vintage Summaries LFLR", ...

All Actions | Sprays & Soil Additions | Total Manhours | Manhours by Block | Weather | BACKGROUND

Action Commentary: **Very Good**: Extensive soil amendment, Good yield, Some picking losses

	Man-hours	Action	Harvest Block: LFLR	LFSR	PetV	CabF	Me2	Me1	Acreage	Curtain	# vines	Substance Added	Amounts per acre: Fungicide [g]	Surfactant [g]	Foliar N [g]	Soil Amend [lbs]	Amounts per curtain ft: Fungicide [mg]	Surfactant [mg]	Foliar N [mg]	Cumulative Manhours: LFLR	LFSR	CF	PV	Me2	Me1	Floor	Plant	Nutr	Pest
																				194	118	34	16	68	33				
Dec 6, 2017	6.30	Soil Amendment	•	•	•	•	•	•	0.80	5.568	588	Oystershell Lime++++				1.121				3	1	0	0	1	0			6	
Dec 29, 2017	2.50	Prunina					•		0.15	732	122									3	1	0	0	4	0		3	6	
Dec 30, 2017	2.00	Prunina						•	0.06	294	49									3	1	0	0	4	2		5	6	
Jan 1, 2018	1.00	Prunina			•				0.06	306	51									3	1	1	0	4	2		6	6	
Jan 1, 2018	1.00	Prunina				•			0.03	156	26									3	1	1	1	4	2		7	6	
Jan 2, 2018	2.00				•	•	•	•	0.31	1.488	248									3	1	2	1	5	3	2	7	6	
Jan 2, 2018	5.50	Prunina		•					0.15	1.224	102									3	7	2	1	5	3	2	12	6	
Jan 3, 2018	1.00	Prunina		•					0.15	1.224	102									3	8	2	1	5	3	2	13	6	
Jan 4, 2018	4.00	Prunina		•					0.15	1.224	102									3	12	2	1	5	3	2	17	6	
Jan 6, 2018	6.00	Prunina		•					0.15	1.224	102									3	18	2	1	5	3	2	23	6	
Jan 7, 2018	0.70	Soil Amendment			•				0.03	156	26	Mushroom Compost++++				16.133				3	18	2	2	5	3	3	23	6	
Jan 7, 2018	0.70	Soil Amendment				•			0.06	306	51	Mushroom Compost++++				16.133				3	18	3	2	5	3	3	23	7	
Jan 9, 2018	4.00					•	•	•	0.31	1.488	248									3	18	3	3	7	4	7	23	7	
Jan 11, 2018	1.00	Soil Amendment						•	0.06	294	49	Mushroom Compost++++				16.133				3	18	3	3	7	5	7	23	8	
Jan 11, 2018	3.50	Soil Amendment					•		0.15	732	122	Mushroom Compost++++				16.133				3	18	3	3	10	5	7	23	12	
Jan 12, 2018	0.30	Mowina	•						0.34	2.856	238									3	18	3	3	10	5	7	23	12	
Jan 12, 2018	0.20	Mowina		•					0.15	1.224	102									3	18	3	3	10	5	7	23	12	
Jan 18, 2018	2.00				•	•	•	•	0.31	1.488	248									3	18	4	3	11	5	9	23	12	
Jan 27, 2018	1.50	Ripping & Tilling					•		0.15	732	122									3	18	4	3	13	5	11	23	12	
Jan 27, 2018	0.50	Ripping & Tilling			•				0.06	306	51									3	18	4	3	13	5	11	23	12	
Jan 27, 2018	0.30	Ripping & Tilling				•			0.03	156	26									3	18	4	3	13	5	12	23	12	
Jan 27, 2018	0.75	Ripping & Tilling						•	0.06	294	49									3	18	4	3	13	6	12	23	12	
Feb 1, 2018	10.00				•	•	•	•	0.31	1.488	248									3	18	6	4	18	8	22	23	12	
Feb 5, 2018	12.00	Prunina	•						0.34	2.856	238									15	18	6	4	18	8	22	35	12	
Feb 7, 2018	4.50	Prunina						•	0.06	294	49									15	18	6	4	18	12	22	40	12	
Feb 8, 2018	6.00	Prunina					•		0.15	732	122									15	18	6	4	24	12	22	46	12	
Feb 9, 2018	4.00	Prunina			•				0.06	306	51									15	18	10	4	24	12	22	50	12	
Feb 10, 2018	2.00	Prunina				•			0.03	156	26									15	18	10	6	24	12	22	52	12	
Feb 10, 2018	1.00	Prunina		•					0.15	1.224	102									15	19	10	6	24	12	22	53	12	
Feb 11, 2018	4.00	Prunina		•					0.15	1.224	102									15	23	10	6	24	12	22	57	12	
Feb 14, 2018	15.00	Prunina		•					0.15	1.224	102									15	38	10	6	24	12	22	72	12	
Feb 24, 2018	42.00	Prunina	•						0.34	2.856	238									57	38	10	6	24	12	22	114	12	
Mar 4, 2018	4.00	Weedina						•	0.06	294	49									57	38	10	6	24	16	26	114	12	
Mar 5, 2018	2.00	Weedina					•		0.15	732	122									57	38	10	6	26	16	28	114	12	
Mar 7, 2018	4.00	Weedina					•		0.15	732	122									57	38	10	6	30	16	32	114	12	
Mar 7, 2018	1.00	Weedina			•				0.06	306	51									57	38	11	6	30	16	33	114	12	
Mar 7, 2018	1.00	Weedina				•			0.03	156	26									57	38	11	7	30	16	34	114	12	
Mar 23, 2018	1.00	Weedina	•						0.34	2.856	238									58	38	11	7	30	16	35	114	12	
Mar 23, 2018	0.80	Mowina	•	•					0.49	4.080	340									59	38	11	7	30	16	36	114	12	
Apr 1, 2018	0.45	Mowina	•	•					0.49	4.080	340									59	38	11	7	30	16	37	114	12	
Apr 3, 2018	5.00	Soil Amendment	•						0.34	2.856	238	Mushroom Compost++++				16.850				64	38	11	7	30	16	37	114	17	
Apr 3, 2018	1.00	Soil Amendment		•					0.15	1.224	102	Mushroom Compost++++				9.490				64	39	11	7	30	16	37	114	18	
Apr 3, 2018	1.00	Weedina					•		0.15	732	122									64	39	11	7	31	16	38	114	18	
Apr 4, 2018	2.00	Weedina			•				0.06	306	51									64	39	13	7	31	16	40	114	18	
Apr 5, 2018	2.00	Weedina			•				0.06	306	51									64	39	15	7	31	16	42	114	18	
Apr 5, 2018	1.50	Pesticide Spray	•	•	•	•	•	•	0.80	5.568	588	+Champ+++	1,126				16.164			65	40	16	7	31	16	42	114	18	2


REVIEW: Vineyard Actions
Vintage 2018
driven by "VintageSummaries",
linked to "VineyardActions for Vintage Summaries", ."VineyardActions for Vintage Summaries LFLR", ...
All Actions
Sprays & Soil Additions
Total Manhours
Manhours by Block
Weather
BACKGROUND
Amendments Commentary
Added Oystershell Lime (to increase pH) and Mushroom Compost (to add nutrients) niformly to all blocks
Cabernet Sauvignon
LFLR
Cabernet Franc & Petit Verdot
Petit Verdot
Merlot
Me2
LFSR
Cabernet Franc
Me1
Sprays [mg per curtain foot]
Fungicide #1
Fungicide #2
Surfac-tant
Foliar N
Soil Amendments [lbs per acre]


REVIEW: Vineyard Actions
Vintage 2018
driven by "VintageSummaries",
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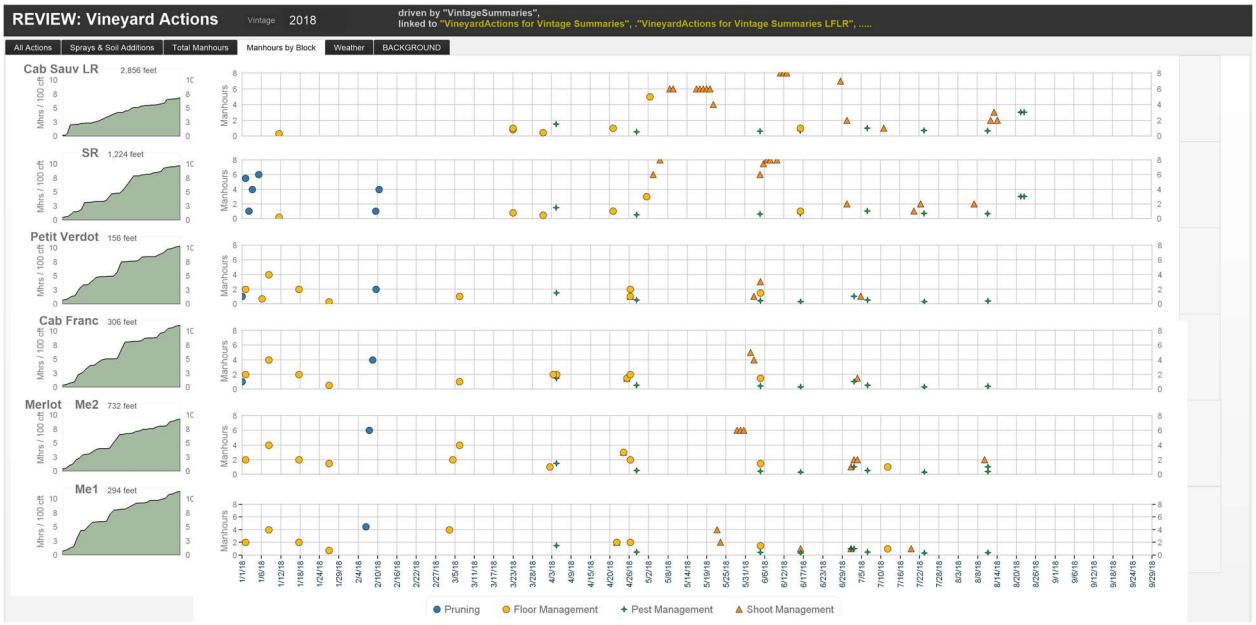
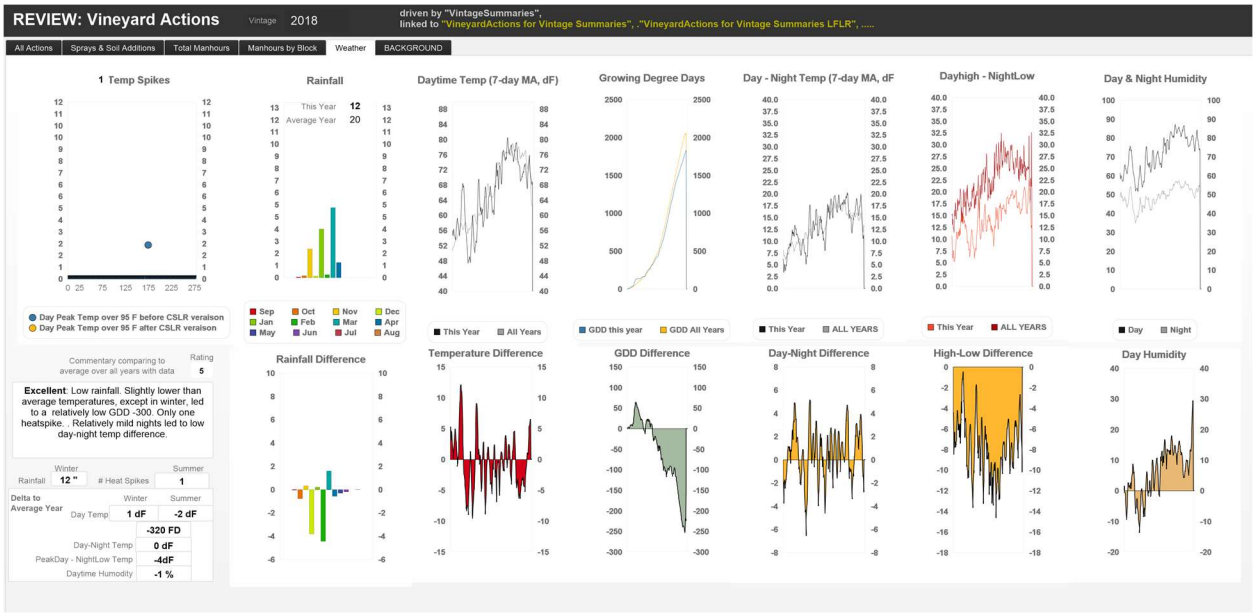
All Actions
Sprays & Soil Additions
Total Manhours
Manhours by Block
Weather
BACKGROUND
Manhours Commentary
First year with detailed recordings of manhours spent
Manhours by Task
Pruning
Floor Management
Pest Management
Shoot Management
Manhours
Cumulative Manhours by Vineyard Block"
LFLR
LFSR
PetV
CabF
Me2
Me1
Cumulative Manhours by Task Type"
Floor
Plant
Nutrition
Pest





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Next Page: Site Preparation

Last updated: March 29, 2021

Site Preparation

Site preparation consists of 5 steps:

- **Topography & layout**: choosing the site and orienting the vineyard rows for optimal sun and wind exposure.
- **Ripping & Terracing**: loosening up the soils, removing old stumps, and terracing the surface if necessary.
- **Soil Analysis & Amendments**: sampling and analyzing the soil to determine what fertilizers to add for a healthy vineyard.
- **Choice of Trellis System**: choosing a trellis system that defines the spacing of the vines and the relationship between the rooting area and the crop density.
- **Irrigation System**: laying out the irrigation pipes, valves, and drip lines.

The following paragraphs expand on these five steps and explain the differences between the Lower and the Upper Fields' choices.

Topography & Layout

The following picture shows the two vineyard layouts projected onto a Google map.

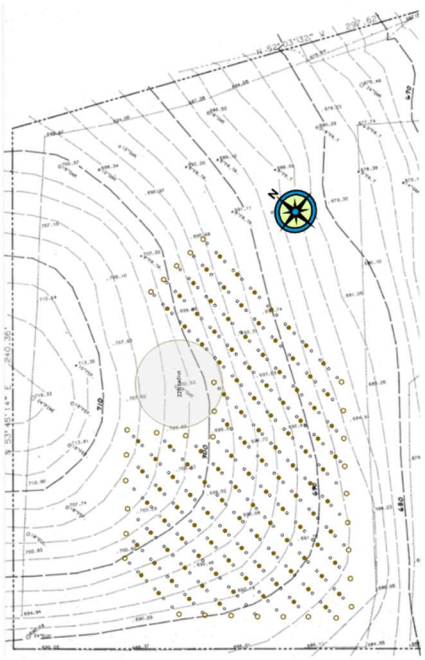
The Lower Field vineyard was planted in 1997 in 14 rows running southwest to north-east, adapting to the land's contours. The direction of the rows was dictated primarily by the

topography. The 333 plants are spaced 6 feet with rows 10.5 feet apart. The total area covered is 333*6*10.5 = 20,979 sqft or 0.48 acres.

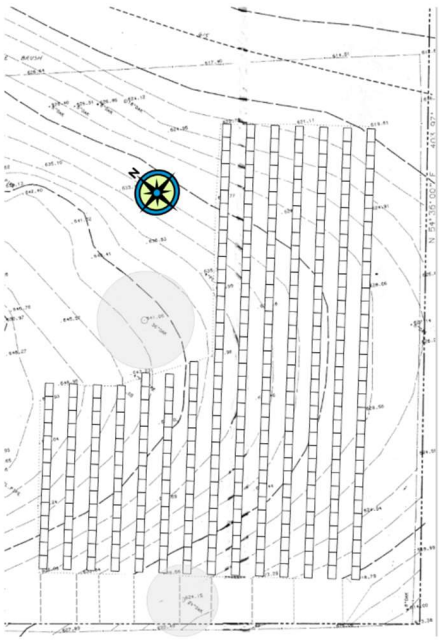
We planted the Upper Field in the spring of 2015 with 16 rows running approximately north-south. The topography allowed a north-south direction of the rows with minimal terracing. The 256 plants are spaced 6' with rows 9 feet apart. The total area covered is 256*6*9 = 13,824 sqft or 0.317 acres.

The following picture shows the two vineyards in topographical maps indicating elevations

Upper Field



Lower Field



Ripping & Terracing

Ripping is necessary to loosen up the soil 2 feet deep, remove dead tree stumps and other debris and destroy the networks of old gopher tunnels. Terracing is advisable to facilitate easy access with tractors for spraying and mowing between the rows.

The Lower Field was ripped and cleaned by Ron Mosley in 1997. We terraced outside the southwest endposts later to allow easier turning after introducing tractors for field maintenance in 2000.

We had the Upper Field ripped 2 feet with a big bulldozer by a contractor (Peter Mesa 408-438-1016). We then terraced it with a box-scaper attached to our tractor to accommodate the slope, particularly on the east side.

Soil Analysis & Amendments

A good starting point for soil composition in California is the online soil map by UCDavis: http://casoilresource.lawr.ucdavis.edu/gmap/

The first step in site preparation is to take soil samples and send them to a laboratory for analysis, highlighting deficiencies in nutrients. We analyze the soil before ripping and terracing, but we add the amendments after.

For the Upper Field, we followed the excellent instructions for taking soil samples at http://www.growyoursoil.org and then submitted samples of topsoil and subsoil to A&L Westen Laboratories (http://www.al-labs-west.com/services.php?section=Soil%20Analysis). We took two samples – one a mixture of 12 topsoil locations spread around the site, the other a subsoil sample at 2.5 feet in the middle of the site. We then had the soil analysis reviewed by GrowYourSoil and by our vineyard consultant, Ron Mosley. Their recommendations were consistent and are summarized in the table.

SOIL Amendment		CH Vineyard Upper Field											
		A&L Reading		Grow Your Soil Recommendation				Ron Mosley recommendation		Decision			
		SubSoil	TopSoil	ideal	per 100sqft	lbs/per vine at 6x9	lbs/acre at 43k sqft/ac	lbs/acre at 6x9 vine spacing	lbs/vine at 6x9	for 256 plants , 0.32 acres	$ price per 50lbs bag	bags	Total Cost
Organic Matter	%	**2.1**	4.4	4-6									
Nitrogen NO3-N	ppm	**5**	8		add 9lbs of alfaalfa meal to add nitrogen (aam is 3-1-2)	4.9	4179.6	add 40 yards of mushroom compost for area		40 yards mushroom compost			525
Phosphorus Weak Br	ppm	**2**	19		add 2lbs of rock phosphate or bone meal	1.1	928.8	Phosphate Bone Meal: add 871 lbs/acre	1.1	280 lbs bone meal	42/40lbs	7	288.0
Phosphorus NaHCO3	ppm	**4**	7	15-30									
Potassium K	ppm	**72**	159	170-420	add 2.5lbs potassium sulfate (potassium & sulfate)	1.4	1161	Potassium KSO4: add 1089 lbs/acre	1.4	360 lbs Potassium 0-0-50	30.0	8	240.0
Manesium Mg	ppm	**1592**	1267	260-390									
Calcium Ca	ppm	**2254**	2080	2800-3200	add 4lbs gypsum (calcium & sulfite)	2.2	1857.6	Gypsum CaSO4: add 1742 lbs/acre	2.2	570 lbs Gypsum	8.5	12	102.0
Sodium Na	ppm	**154**	32										
Sulfur SO4-S	ppm	**5**	4	30-50	sufficient sulfate will come in through fertilizers								
Zinc Zn	ppm	**0.3**	0.8	1.5-10	add 0.5oz zinc sulfate	.25 oz	13	Zinc Sulfate: add 22 lbs/acre	0.44 oz	7lbs Zinc Sulfate (35%Z)	58.00	1	58.00
Manganese Mn	ppm	**2**	11	15-50	add 0.2oz manganese sulfate	0.1 oz	5	Manganese Sulfate: add 9 lbs/acre	0.18 oz	3lbs MnSulfate (10%Mn)	20.00	1	20.00
Iron Fe	ppm	**9**	18	20-40	add 0.2oz iron sulfate	0.1 oz	5	Iron Sulfate: add 9 lbs/acre	0.18 oz	3lbs FeSulfate (30%Fe)	27.00	1	27.00
Copper Cu	ppm	**1.9**	3.3	1.5-3									
Boron B	ppm	**0.4**	0.2	1-1.5	add 0.5oz of borax	0.25 oz	13	Boron: add 22 lbs/acre	0.44 oz	7lbs BSulfate (20%B)	82.00	1	82.00

We spread all additions evenly across the vineyard acreage during the winter rains after ripping and terracing the site.

Lower Field

We have no records of the original soil analysis and amendments by Ron Mosley in the Lower Field in 1997. After we ripped out 70 weak plants in autumn of 2014, we did a soil analysis in January of 2015 which indicated a very low pH, or high acidity. Following recommendations by John Beeby, we made the additions suggested during tilling in the cover crop.

Grow YOUR SOIL

Organic fertilizer recommendations and consulting to improve your soil's fertility sustainably www.growyoursoil.org
Recommendation for Till Guldimann, Lower Vineyard (Samples LFSE and LFW averaged)

Test	2015 Results	Ideal Range	Recommendations (per 100 square feet)	Application: per 100 sqft amount	unit	per plant	Total 63	20,979	Purchase Requirement: ccft/yard	#yards	$/yard	$Total
Organic Matter (%)	3	4-6	**Add 3 cubic feet of cured compost per 100 square feet.** Ideally, this would be your own farm-produced cured compost, but purchase cured compost as needed. which ideally would be vegetable based, but could be animal manure based if necessary. Be sure to grow 50-60% of your area in carbon and compost producing crops like maize and small grains, in order to produce enough compost from your farm to maintainand improve the soil's organic matter level.	3	cft	1.89	629	Mushroom Compost	27	23.31	13	303.03
CEC (meq/100g)	26.25								lbs/bag	#bags	$/bag	
pH	5.6	6.0-7.0	**Add 23 lbs of agricultural lime per 100 square feet** to increase your soil pH and to improve your calcium and magnesium balance.	23	lbs	14.5	4,825	Agricultural Lime CaCO3 (not dolomitic lime)	50	96.50	8	772.03
Buffer pH	6.4											
Calcium % Sat	32.95	65-75										
Magnesium % Sat	40.95	10-15										
Potassium % Sat	1.35	2-5										
Sodium % Sat	1.25	<5%										
Hydrogen % Sat	23.5											
Calcium (ppm)	1725	3419-3945										
Magnesium (ppm)	1308.5	319-479										
Potassium (ppm)	138.5	205-513	**Add 3 lbs of potassium sulfate per 100 square feet** to increase your soil's potassium and sulfate levels.	3	lbs	1.89	629	Potassium Sulfate (yara) 0-0-50	50	12.59	30	377.62
Sodium (ppm)	74.5											
Hydrogen (meq/100g)	6.2											
Estimated Nitrogen Release (lbs/acre)	89.5		I recommend that you recycle as much of your organic residues through composting and/or mulching, and periodically grow legumes and harvest them at 50% flower to maintain your nitrogen level sustainably.									
Phosphorus (ppm)	11 LFW and 41 LFSE (Weak Bray)	25-40	***FOR THE LFW AREA ONLY***: **Add 5 pounds of bone meal per 100 square feet** to add phosphorus to your soil.	5	lbs	3.15	284	LFA AREA ONLY (90 plants) Phosphate Bone Meal (Borax)	40	7.09	42	297.68
Sulfate (ppm)	15	25-35										
Zinc (ppm)	0.55	3-6	**Add 1 ounce of zinc sulfate per 100 square feet** to add zinc (and a minor amount of sulfate) to your soil.	0.0625	lbs	0.04	13	Zinc Sulfate (Maximo 360): Z - 35.5%, S 17.5%				
Manganese (ppm)	5	5-30										
Iron (ppm)	29.5	16-25										
Copper (ppm)	1.5	1.2-2.5										
Boron (ppm)	0.45	1-1.5	**Add 0.5 ounce of a 15% boron fertilizer (such as borax) per 100 square feet** to add boron to your soil.	0.025	lbs	0.02	5	Solubor (Borax) Sodium Borate : B - 20.5%				
EC (Salts) (mmhos/cm)	0.2	< 1.5										
Texture												

Testing Laboratory: A&L Western (DTPA)

Notes: The recommended fertilizers and application rates above should be applied once and will be sufficient for one year, after which we recommend that you retest your soil. When you apply the fertilizers, you will want to broadcast each fertilizer, one at a time, evenly over each bed. Because one of your recommended fertilizers (agricultural lime) adjusts your soil pH, you should add that fertilizer by itself first, mix it into the top 2 to 4 inches of soil, and then wait one month before adding the rest of the recommended fertilizers and compost. To make it easier to broadcast evenly, first add a light colored fertilizer against the darker soil. Then, add a darker fertilizer, followed by a lighter one, etc. To help evenly apply very small amounts of fertilizer (less than 2 ounces), it can be helpful to thoroughly blend the proper amount of a single fertilizer with a few handfuls of drier, finely textured soil, and then broadcast this larger volume mixture over the area. After you have added all of the fertilizers and compost, you can mix them into the top 2 to 4 inches of soil (typically with a garden fork, using a sifting motion) and the soil is ready to be planted. If you have any questions on this recommendation, have trouble locating any of the fertilizers recommended, or seek guidance to achieve greater sustainability and minimize your needs for fertilizers, please contact John Beeby of Grow Your Soil: **jsbeeby@gmail.com**.

We purchased the fertilizers from Sierra Pacific Turf Supply (www.sierrapacificturf.com) in San Jose and the compost from B&D Mushrooms in San Martin (through Gordon Hodges Trucking 1-408-888-9291).

There is a problem with soil composition: it is challenging to change. Adding chemicals and nutrients is often nothing but a temporary fix for the current season. That is why “terroir” is so important. The best way to improve the soil is to build a healthy environment for organisms that generate some of the plants’ nutrients. Compost from multiple sources is way more effective long term than industrial chemicals.

Trellis Systems

Vines have a complex system of roots below ground and a highly crafted architecture of trunks, arms, cordons, and shoots above ground. The picture on the side provides an excellent view of a carefully excavated mature vine. From http://disciplegideon.files.wordpress.com/2012/07/grapvine-roots.jpg

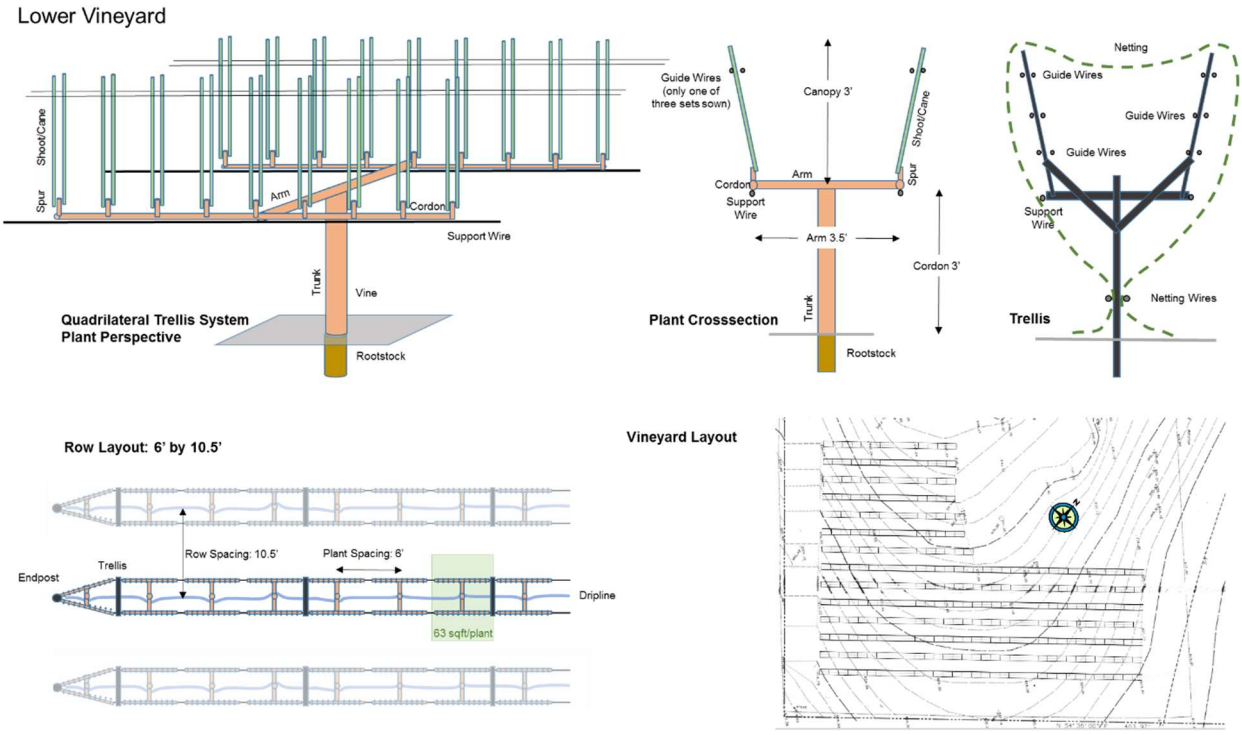
Above ground, the trellises hold up the vines and expose the grape bunches and leaves evenly to sunshine and air movement. We use the following vocabulary (adapted from Fundamentals of Grapevine Pruning by Ed Kwiek, Feb/March 2014 Winemaker Magazine) for describing different parts of the vine:

- Trunk: a permanent, vertical stem of the vine (above ground)
- Arm: permanent horizontal extensions of the trunk connecting the trunk to the cordons
- Cordon: wood that is two or more years old, trained along a wire
- Cane: a mature shoot after leaf fall
- Spur: a cane that has been pruned back to 1, 2, or 3 buds (a compound bud)
- Node: location of a compound bud
- Bud: an undeveloped embryonic shoot
- Shoot: new green growth with leaves, tendrils, and flower clusters developing from a bud of a cane or spur. Each shoot produces 2-3 clusters of grapes.
- Lateral: a branch of a shoot
- Sucker: a shoot growing from old wood on the trunk, arms, or cordons (rather than from shoots or canes)
- Tendril: a twisting, threadlike part of the shoot that wraps around wires and other shoots to provide support

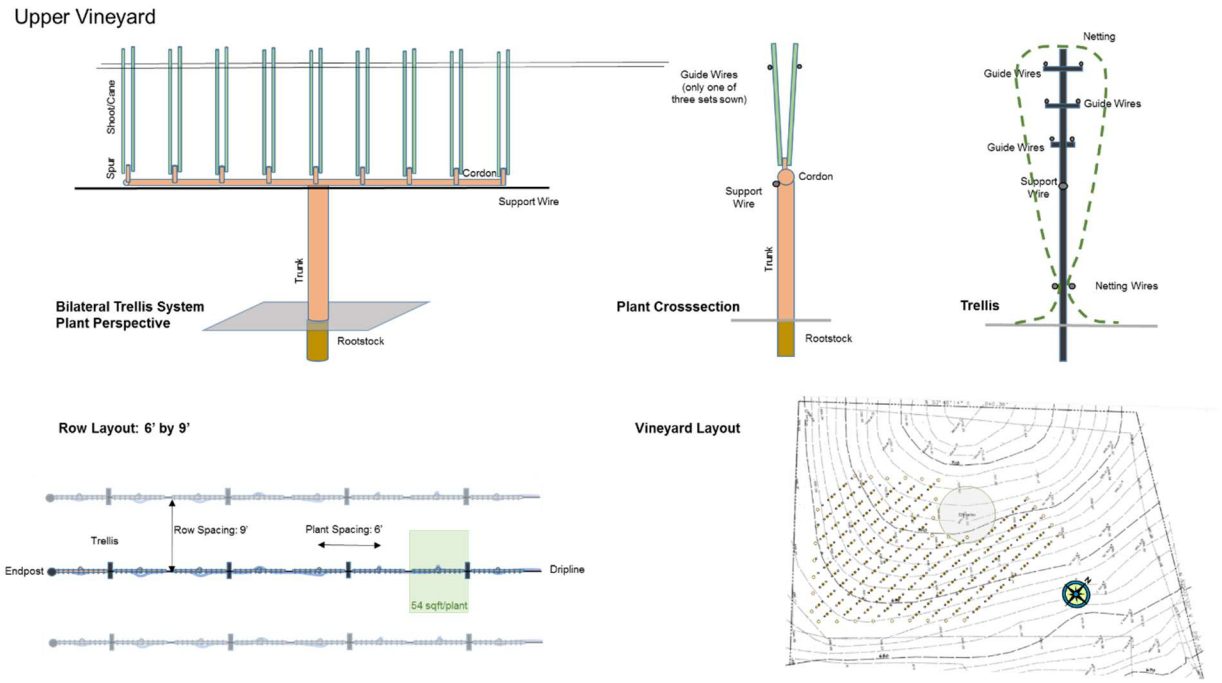
There are many different types of trellis systems.

For the **Lower Field**, Ron Mosley chose a quadrilateral trellis system. The picture below illustrates what this means. The trunk of the vine splits into two arms, each of which splits again

into two cordons. Endposts delineate the end of the rows and trellises after every third plant support the guide wires. This is a complex system with the advantage of widely spaced rows for tractors without giving up too much crop density. It only works in soils where a single root system can support a large plant. The disadvantage of quadrilateral trellises is labor-intensive pruning, canopy management, and netting because you can only access the fruit zone from one side of the cane curtain.

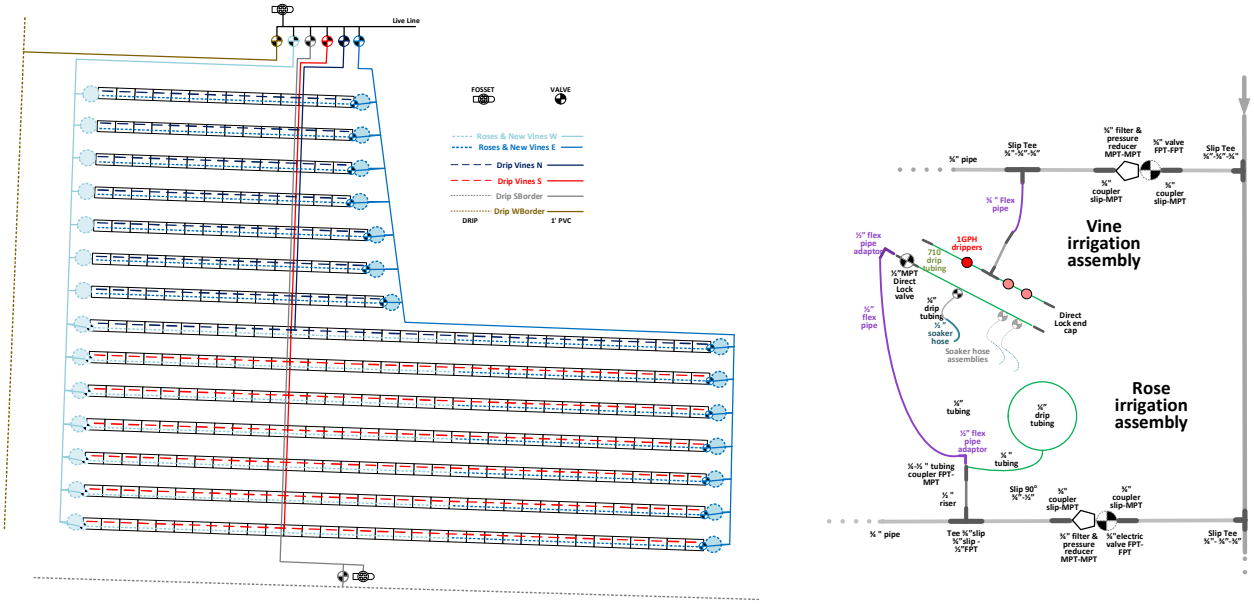


For the **Upper Field**, we chose a bilateral trellis system. It allows easy access to the canopy and fruit zone from both sides of the vine. This simplifies pruning and canopy management, but bilateral systems have lower crop density for a given row spacing.

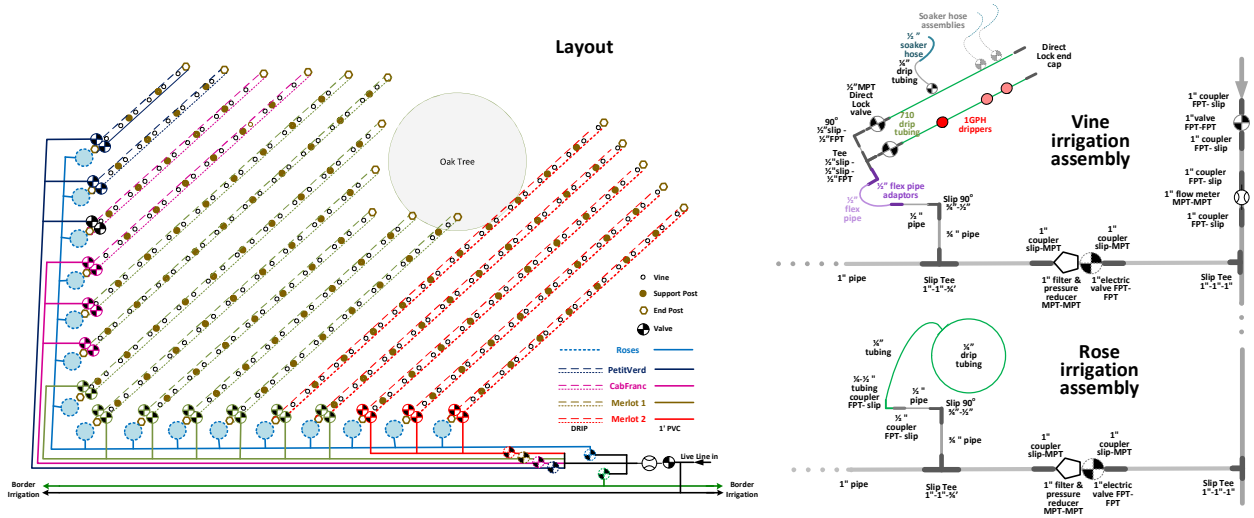


Irrigation System

Lower Field Irrigation: The irrigation system has two manually switched drip lines for the vineyard, one for the northern half, the other for the southern half. Besides, there is an electrically switched line for the roses at the east endposts, and there are two switched lines for irrigating the border plantings south and west. In 2015 we extended the irrigation system for the roses into the vineyard rows with drip tubing. Now we can irrigate the newly planted vines more frequently than the mature vines.



Upper Field Irrigation: Each row has two driplines: one is for surface drippers, the other for 3 feet soaker hoses buried under each plant. The root soakers can be regulated individually. The rows are divided into areas for different grape varieties (Merlot, Cabernet Sauvignon, Cabernet Franc, and Petit Verdot), and each of these areas has a remote-controlled valve. At each endpost, there is drip irrigation for roses; this circuit is also on a remote-controlled valve. Furthermore, there is a live line and a switched line going to the east and west borders for irrigation. The following chart shows the layout and the component assemblies for the vine and rose irrigation lines.



Interesting website on irrigation supplies: http://www.urbanfarmerstore.com/wp-content/uploads/2012/12/DripHandbk.pdf

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Last updated: April 15, 2021

Planting & Replanting

New vines are best planted in early spring, and for the first three years after that, they are managed not for fruit production but for growing their root systems and strengthening their trunks, arms, and cordons. Grapes can be harvested starting the end of the third season, but their quality is not optimal until the end of the 6th or 7th season. Because we lose vines due to diseases and destruction by animals, we need to add some new plantings every 4-5 years.

This page describes:

- How we select rootstocks and vines and what we planted and replanted first in the Lower Field, then in the Upper Field
- How we planted the vines and how we take care of them during the first three years.

Selecting Rootstocks & Vines

Ever since the phylloxera epidemic over a century ago, standard practice is to graft a grapevine selected for its fruit on a rootstock chosen for its resistance to pests and adaptability to soil conditions. Thus we need to choose combinations of a rootstock with a vine suitable to our climate, soil condition, and grape variety.

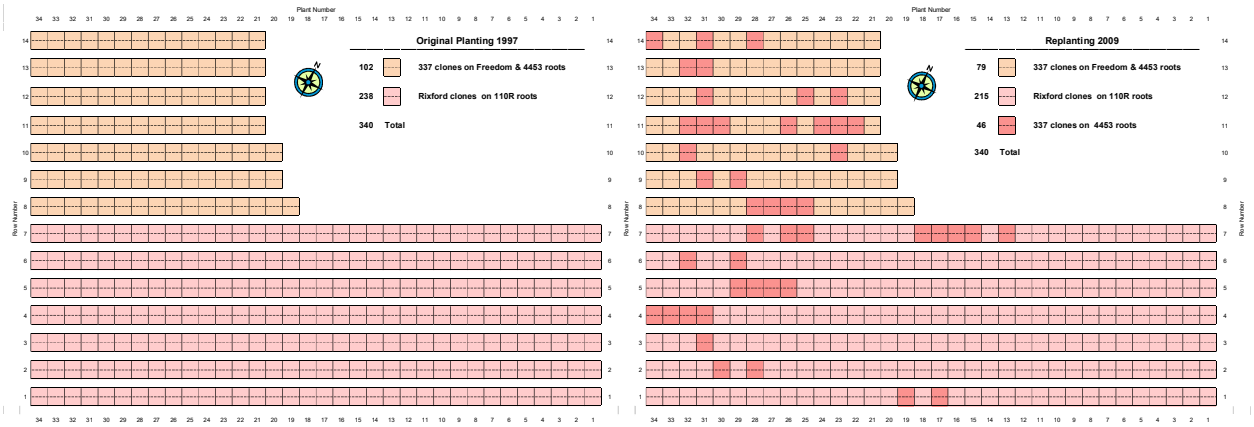
- A good article on how to select rootstocks can be found here http://iv.ucdavis.edu/files/24347.pdf. A comprehensive list of available rootstock is at http://vintagenurseries.com/resources/rootstock-guide.pdf. A good discussion on rootstocks is at http://www.lodiwine.com/AWalkerRootstocks5-8-12.pdf.
- A comprehensive list of grape vines registered in the U.S. can be found here: http://ngr.ucdavis.edu/varietylist.cfm. UC Davis runs Foundation Plant Services (http://fpms.ucdavis.edu/), a service that produces, tests, maintains and distributes virus and disease-tested plant material for propagation by nurseries.

The selection of grape varieties is large, but relatively few are widely used. Furthermore, the final rootstock/vine selection is often restricted by what is available at the nurseries nearby.

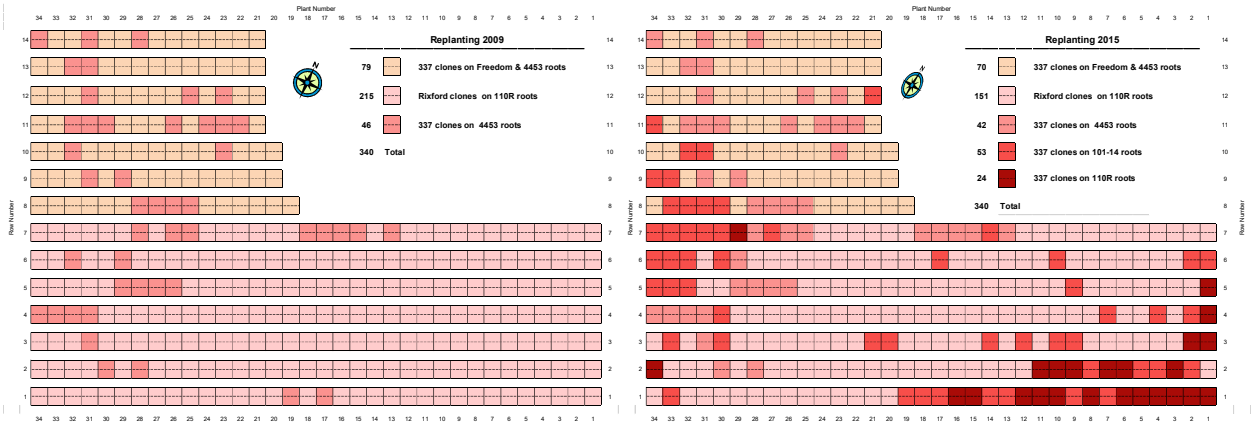
Lower Field: Ron Mosley planted 340 vines in July 1997. He, unfortunately, lost the original planting documents, so the following is from his memory as of 2013 and a comparison of anthocyanin concentrations in berries in 2015.

- Some of the seven long rows in the southwest (34 plants each) were planted on “Freedom” roots with 337 cabernet clones; the other rows were planted on “4453” roots, also with 337 cabernet clones.
- The seven short rows in the northeast (14-16 plants each) were planted on “110R” rootstock with “Dr. Emmet Rixford” cabernet clones. The Rixford clones have a lineage back to La Questa, a historic vineyard in the South Bay. They trace their history back to Margaux in Bordeaux and are currently propagated by Mount Eden Vineyards.

Due to gophers, which we failed to eliminate in time, we lost around 50 vines in 2006 & 2007. The lost spots were replanted in 2009 with 50 CabSauv vines clone 337 on 4453 roots. The following graphic shows the locations.

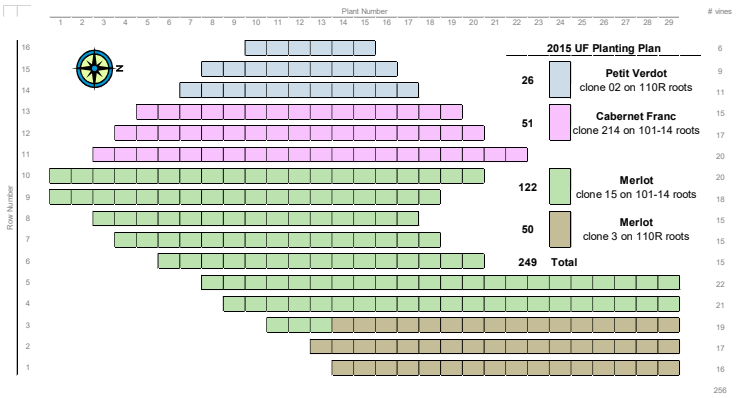


By 2014 more vines were lost due to Eutypa, gophers, and rototiller malfunctions, so we decided to initiate another significant replant in 2015 with cabernet clones 337 on 101-14 roots purchased (dormant bare roots) from Vintage Nurseries. When many of these bare root plantings failed due to false instructions from Vintage Nurseries, we needed to replant them with new green plants of clone 337 on 110R roots.



For the 2015 replanting, we modified the irrigation system to irrigate the new vines automatically every week.

Upper Field: In the spring of 2015, we planted grape varietals that complement Cabernet Sauvignon in typical Bordeaux blends. With advice from Ron Mosley and given availability at different nurseries, we settled on the following clone/rootstock combinations:



- 26 Cabernet Franc clone 214 on 101-14 roots from Mercier Groupe (dormant potted),
- 51 Petit Verdot clone 02 on 110R roots from Vintage Nurseries (dormant bare roots)
- 122 Merlot clone 15 on 101-14 roots from Vintage Nurseries (dormant bare roots), and
- 49 Merlot clone three on 110R roots “Ueber”-vines from Duarte Nurseries (green potted).

The green potted Merlot “Ueber”-vines from Duarte were planted in 5-gallon pots in spring 2014 and replanted in the upper field in April 2015. We received the bare roots in May, boxed in moist sawdust.

Planting and Growing first three years

The original instructions from Vintage Nurseries were: “The bare root vines are warmed up to bud-swell and planted in a 14” pre-irrigated hole. The graft union is set around 4” above soil level. Then, a mound of loose soil is built over the vine 1” above the tip of the vine. This mound protects the vine from drying out until the roots take hold. When green growth is showing, about two weeks later, the mound is removed, and a shelter tube is put over the vine for the remainder of the planting season”. Unfortunately, these instructions were wrong; 50% of the vines died! Vintage Nurseries provided replacements and new instructions: The bare root vines are acclimated for 2-3 weeks, then soaked for 4-6 hours in water before planting. No mound of dirt is needed for summer plantings; the plants are protected with a shelter tube from the getgo.

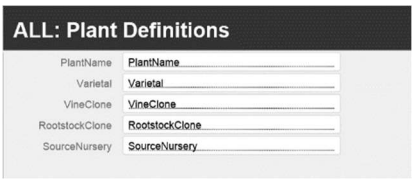
New vines need moist soil during the first summer, so we irrigate twice a week with 1 gallon/plant through the buried soaker hoses. Plants that struggle get another 1 gallon twice a week with a surface drip.

Data Management

Four tables in our database define and track the planting of vines:

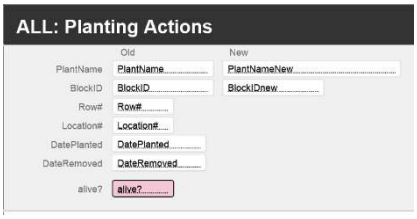
- PlantDefinitions defines which vine-rootstock combination we use
- PlantingActions records which plant is planted or removed at a given location
- FieldLocations records on a map which location holds a particular vine at a given date
- HarvestBlockDefinitiion describes for each vintage how we delineate and describe harvest blocks.

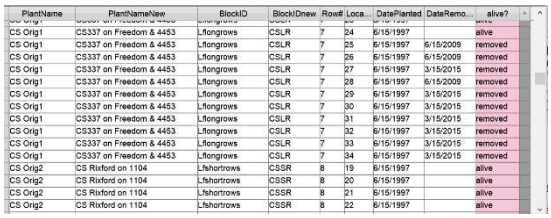
The layout “ALL: Plant Definitions” shows the field we use to describe a vine. Here are screenshots of the layout with the field names and a table listing all the records.



PlantName	Varietal	VineClone	RootstockClone	SourceNursery
CS Orig1	Cabernet Sauvignon	337	Freedom	Ron Mosely
CS Orig2	Cabernet Sauvignon	Rixford	110R	Ron Mosely
CS Replant1	Cabernet Sauvignon	337 NC	4453	Duarte
CS Replant2	Cabernet Sauvignon	338 NC	101-14	Vintage Nurseries
CS Replant3	Cabernet Sauvignon	339 NC	110R	Vintage Nurseries
Me Ueber	Merlot	3	110R	Duarte
Me	Merlot	15 FG / 181	101-14	Vintage Nurseries
PV	Petit Verdot	02 FG	110R	Vintage Nurseries
CF	Cabernet Franc	214	101-14	Mercier Groupe

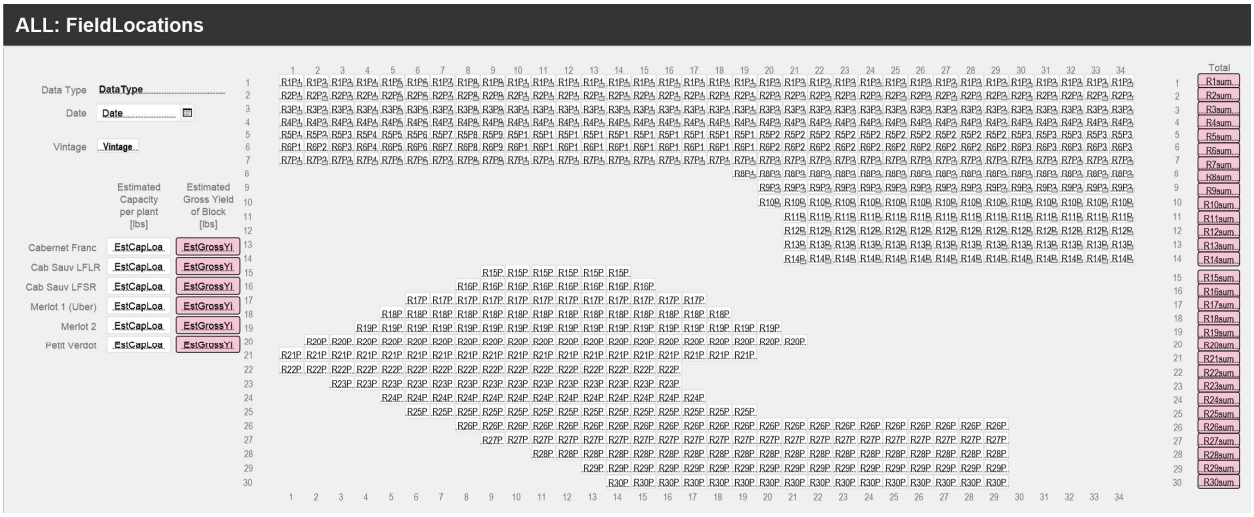
The layout “ALL: PlantingActions” shows the fields we use to describe planting and removal locations. We use this table also to rename the plant and the block. This table has over 700 records, each telling when we planted a new vine and if it has already been replaced when we removed it. The second screenshot show only a part of the table.

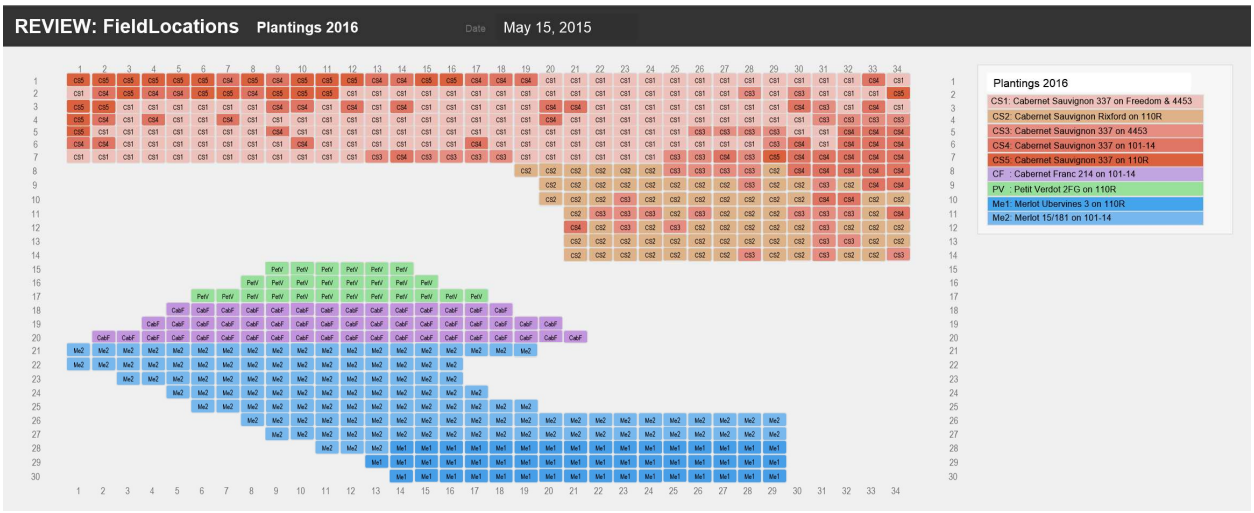




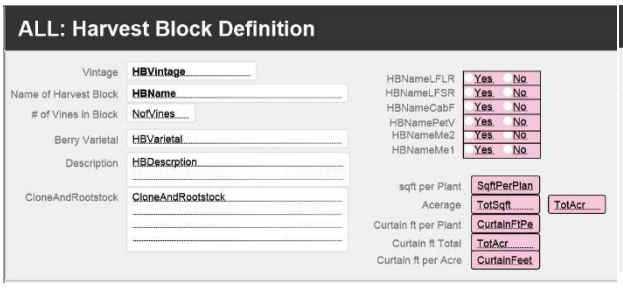
PlantName	PlantNameNew	BlockID	BlockIDnew	Row#	Loca...	DatePlanted	DateRemo...	alive?
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	24	6/15/1997		alive
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	25	6/15/1997	6/15/2009	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	26	6/15/1997	6/15/2009	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	27	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	28	6/15/1997	6/15/2009	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	29	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	30	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	31	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	32	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	33	6/15/1997	3/15/2015	removed
CS Orig1	CS337 on Freedom & 4453	Lflongrows	CSLR	7	34	6/15/1997	3/15/2015	removed
CS Orig2	CS Rixford on 1104	Lfshortrows	CSSR	8	19	6/15/1997		alive
CS Orig2	CS Rixford on 1104	Lfshortrows	CSSR	8	20	6/15/1997		alive
CS Orig2	CS Rixford on 1104	Lfshortrows	CSSR	8	21	6/15/1997		alive
CS Orig2	CS Rixford on 1104	Lfshortrows	CSSR	8	22	6/15/1997		alive

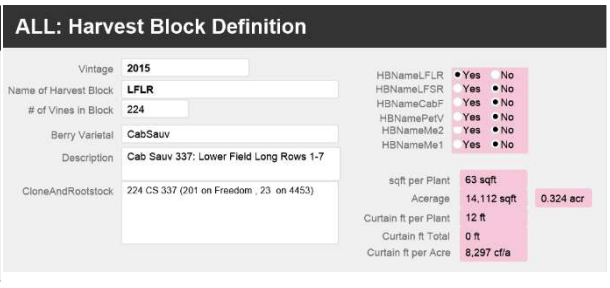
The table FieldLocations shows the vineyard map and what exactly is planted where at given points in time. We also use this table to track fruit loads (see Winemaking section). The following screenshots show the names fields (ALL: FieldLocations} and how we use the table to visualize the map and plantings on a particular date (REVIEW: FieldLocations)





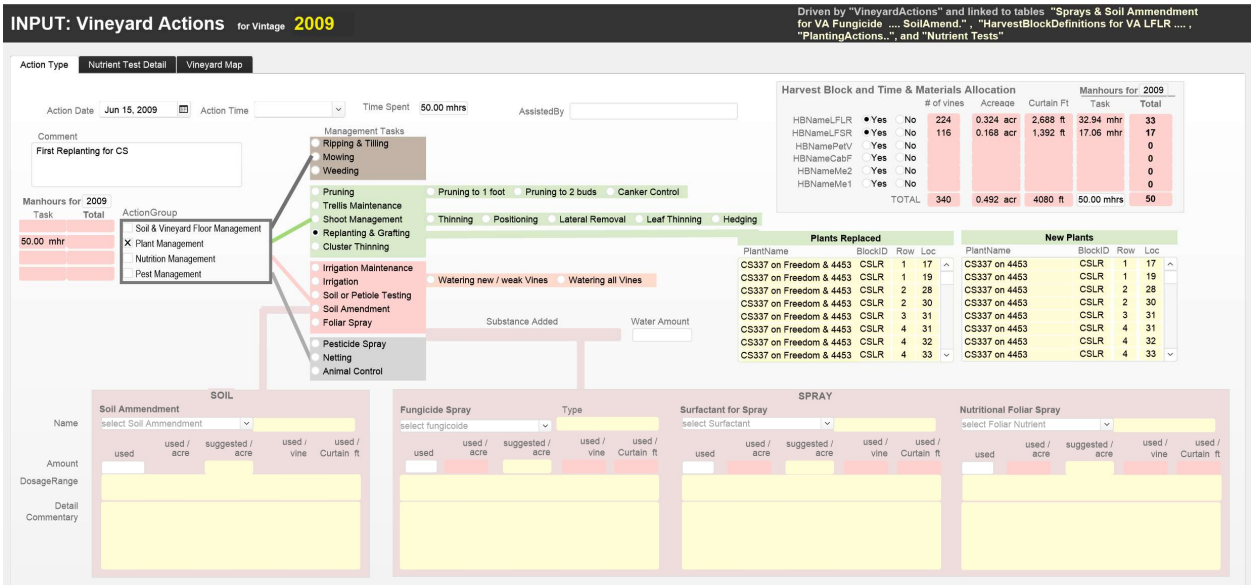
The HarvestBlockDefinition table defines harvest blocks for each vintage. The following





screenshots show the field names and, for example, the LFLR block for 2015.

Plantings and replantings are recorded as individual new entries in the PlantingActions table and, altogether, as an entry in the VinyardActions table under the caption “Plant Management.” Here is a screenshot of the “INPUT: VineyardActions” – Layout for the recording of the June 2009 replantings of 50 Cabernet Sauvignon vines in the lower vineyard



Previous page: Site Preparation
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Next Page: Soil & Vineyard Floor Management
Last updated: April 25, 2021

Soil & Vineyard Floor Management

On this page, we review the annual tasks (except fertilizing) for maintaining the soil and vineyard floor:

- **Cover Crops** are plants, primarily grasses, and legumes, that cover the vineyard floor
- **Ripping & Tilling** is about removing weeds from the vineyard floor and aerating the soil
- **Mowing** is about keeping the cover crop dense and short to notice rodent activity
- **Weeding** is about removing vegetation that competes for nutrition and sunlight

Cover Crop

During winter, we grow a cover crop on the vineyard floor, mostly perennial clover. This prevents erosion during the winter rains and replenishes the soil with nutrients (primarily nitrogen). The selection of cover crops and the practices to manage them are complicated, and I don't yet understand them adequately. The resources section refers to a good book on the subject: "Cover Cropping in Vineyards." We introduced cover crops around 2005 when we decided to stop spraying the vineyard floor with herbicides to control weeds (not a healthy practice).

Tilling & Ripping

Every two to three years in early April, we till in the cover crop and weeds under each row of vines with a rotary tiller that moves around the vine trunks and trellis posts (Weedbadger Model 4000-SST attached to a John Deere 3720). Before 2004, we used pre-emergents and weedkillers (Roundup) to prevent the growth of cover-crop under the wines. While this was efficient in labor,

we realized it was harmful to the vines and vegetation around, so we switched to mechanical tilling.

In May, we re-till under the vines with a small hand-held tiller, or we use a weed-whacker to remove the remaining grasses and regrowth (we use a Stihl MM55C tiller or a Dewalt DCST970 weed whacker). Tilling helps to contain the gopher pest as it destroys their tunnels, but it also eliminates the roots of the perennial clover.

We rip the ground between the vines every 5-10 years to reduce compaction from the tractor, to aerate the soil, which helps to keep it healthy and to destroy gopher burrows. We can only rip in late spring when the ground is still moist – in summer, the soil is too hard to get the ripper to a depth of 2 feet; in winter, the soil is too soft for the heavy tractor.

Mowing

From January through April, we mow the cover crop every 1-2 weeks between the vine rows to promote growth and detect gopher mounds (we use a John Deere X749). There are two benefits of regular mowing: a) the cover crop grows more densely and b) we can quickly identify the new gopher mounds (see Wild Life Control)

Weeding

We remove weeds under the vines. In the lower field, we do that by mechanical tilling or weed-whacking, as described above. In the upper field, we weed by hand because of the terracing. A dense cover of clover helps to suppress weeds. The picture shows the upper vineyard after the rows have been tilled between the vines and the weeds have been removed under the vines (only the cover crop, clover remains).

Previous page: Planting & Replanting
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Next Page: Plant Management
Last updated: April 26, 2021

Plant Management

On this page, we describe the annual tasks tending the vines and maintaining the structure that supports them. We cover

- **Pruning**: cutting back last year's shoots
- **Grafting**: adding new cane buds (possibly from a different varietal)
- **Trellis Management**: maintaining the structure that holds up the vines
- **Shoot Management**: managing the individual shoots
- **Cluster Thinning**: thinning out unwanted berry-clusters

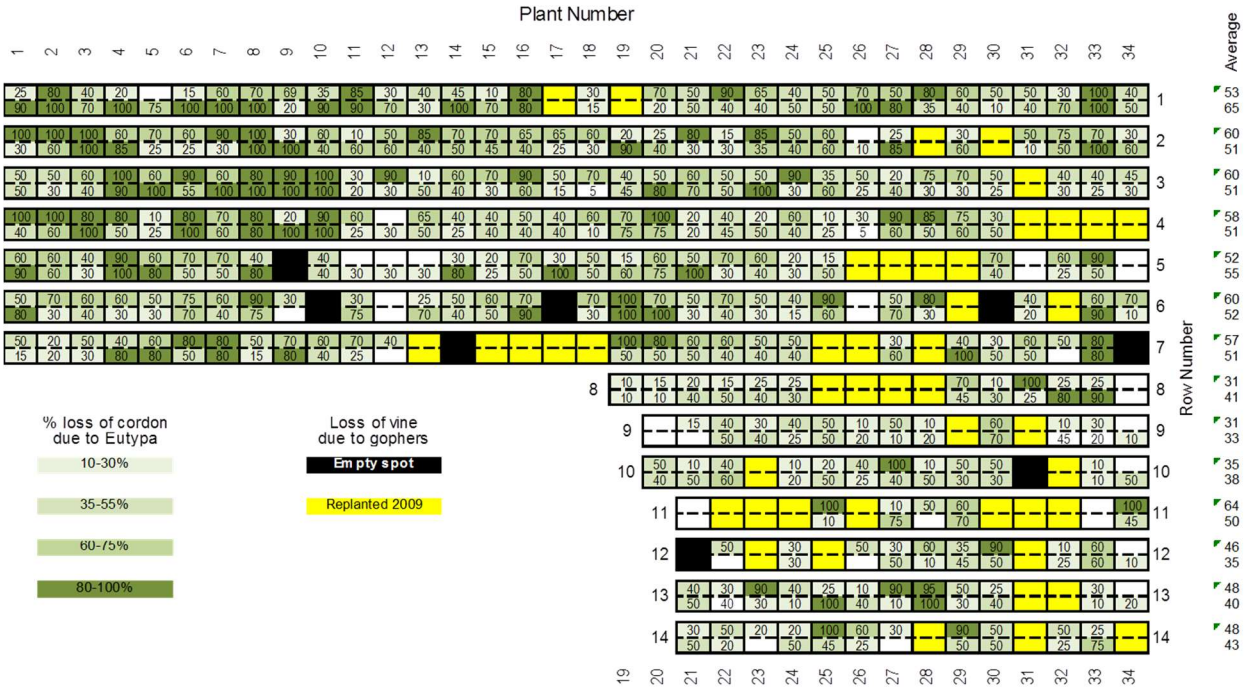
We conclude this page with a note about **Data Management**.

Pruning

Pruning is about cutting back last year's canes to one or two buds where we expect new shoots to grow in the current season.

Since 2014 we prune in two steps – before we pruned in one. In the first round, in February, we cut last year's canes down to 6-inch stubs. In March, we cut the remaining stubs leaving a 2-bud spur on nodes around 6 inches apart. In both rounds, after cutting each row, we paint all cuts with a solution of Topsin M WSB (Thiophanate-Methyl Fungicide, EPA No. 73545-16-70506) by United Phosphorus to prevent infection with Eutypa. Following the second round, we spray the entire vineyard with Rally 60W to further protect against Eutypa. In 2015 we started using a new protectant Vitiseal Safecoat (by Vitisal International LLC, http://www.vitiseal.com/Home.html), which proved to be more effective than the Topsin / Rally combination; it claims to not only seal but also fight Eutypa and other wood diseases and cankers. Rain spreads the Eutypa and canker spores which infect the cutting wounds. The two steps allow starting pruning early, beginning of February, while it still rains. Infections don't invade the wood more than 1 inch per month; thus, any new disease can be safely cut off in round two in late March. The following pictures illustrate the before and after step 1 and step 2.

We learned about the hazards of Eutypa the hard way. In 2008 & 2009, we decided to prune the vines back more than before, but we did not know about the danger of Eutypa infections when leaving significant cuts exposed without protection. As a consequence, practically every vine got infected. It took over six years to detect and cut out the bulk of the infected arms, and we lost over 60% of the fruit-bearing potential in 2010-2015 until new growth replaced what needed to be cut out. The following graphic illustrates the extent of the damage done by early 2013; it shows the percentage of Eutypa infected cordons cut out and replantings due to gopher and Eutypa damage. We continue to have to cut out infected cordons.



We use electric pruning shears (Electrocoup F3010 by Infaco) to make cleaner cuts and are less fatiguing than hand clippers. On completion, we chip all cutoff material into mulch for

ground cover.

After pruning, we reattach the arms to the guidewires. We used a battery-powered tying machine (A3M v2.0 by Infaco) for very loose ties of young arms in the past, but the metal wire turned out to be more harmful than beneficial. Now, we tie the arms with a plastic tie by hand or with one of the two tie-tools pictured on the right.

Grafting

Grafting is about inserting a dormant bud into a cut on a live vine during late winter / early spring. The bud is encouraged to connect and grow into a new cane by pruning off the stem of the live vine just above the inserted bud. The primary purpose of grafting is to switch the clone or varietal of the vine.

We have not done any grafting yet, so no further info.

Trellis Management

We deployed two different trellis systems: quadrilateral for the lower vineyard and bilateral for the upper vineyard. We started with over-the-canopy nets deployed at Veraison and removed after harvest. Because they are a pain to put on and take off, we replaced them with permanently installed side-nets in 2016-2019. The trellis also carries irrigation hoses. So, altogether it's a complex system of poles, wires, hoses, and nets that takes a fair amount of upkeep. The maintenance is best performed after pruning when the vines are compact without shoots and the ground is still soft.

Shoot Management

Shoot Management is very labor-intensive and covers a multitude of tasks:

- **Shoot Thinning**: eliminating excess new shoots
- **Cane Positioning**: positioning shoots vertically between trellis wires without crossing each other
- **Lateral Removal**: removing secondary shoots which crowd the canopy
- **Leaf Thinning**: removing leaves in the fruit zone
- **Hedging**: limiting the length of shoots to 3-4 feet.

The goal of shoot management is an even and airy canopy with evenly distributed grape clusters, each getting approximately the same exposure to the sun. Proper airflow limits mildew infections, uniform sun exposure helps all fruit to mature at around the same day (harvest day)

Shoot Thinning

Our vines have vigorous growth due to the choice of rootstock, the climate, and soil fertility. The advantages are that the plants can recover well from diseases and the many shoots provide

more options for positioning. The disadvantage is that the vines need a lot of spring thinning and pruning because they produce far too many new shoots every year.

We start to shoot thinning in late April when the most extended new shoots are up to one foot long. We eliminate all new shoots which are not positioned well or are deemed excessive for the ultimate density of grape bunches desired. On average, we eliminate around 50% of all shoots. Our general thinning rules are:

- Every spur, cut to 2 buds earlier, should have only two new shoots. We often see three or even more shoots.
- We eliminate new shoots emerging between spurs only if they fill a gap or are at a base of a spur that we may want to replace next year.

It takes less time when thinning is started early, and excess buds can be snapped off quickly. The longer you wait to thin, the more labor-intensive it becomes.

May is also the perfect time to inspect the vine for Eutypa or “dead-arm disease.” The symptom to look for is stunted shoot growth with small yellowing leaves. Eutypa is a fungus that attacks the wood of the vine and ultimately kills the plant. Early detection and removal of the infected wood are essential if you want to save a plant. For more detail, see this webpage: http://www.extension.org/pages/31525/eutypa-dieback-or-dead-arm-of-grapes. We had a lot of Eutypa in 2009-11 after we pruned the vines too aggressively without protecting the open cuts. After every cut, we now paint the open wound with a solution of VitiSeal which protects the wound (defensive) and supposedly fights the already established fungi (offensive). The following pics show a typical progression of cutting out Eutypa

Cane Positioning

Cane positioning is about putting all canes between the guide wires to point up vertically and not cross each other. We usually start in mid-May when the shoots have reached an average length of ~2 feet. Ideally, we position before bloom so that the flowers don't get disturbed by the abrupt movements and develop successfully into berries. The purpose of cane positioning is threefold:

- first to create an airy canopy, so infections by powdery mildew are less likely, and spraying is more effective;
- second to give all bunches approximately equal exposure to sun and shade, so the grapes develop more evenly; and
- third to manage and equalize the length of each cane, again to manage balanced maturing of the grapes.

We put the canes between the bottom guide wires, which are then held together with C-clips.

As the canes grow, more rounds of positioning are required over the next six weeks to do the same with the middle and the top guide wires.

Lateral Removal & Leaf Thinning

We need to contain vegetative growth and channel energy into producing optimal grapes. Earlier in the year, we contained the canopy by eliminating surplus shoots. Now we need to contain the growth on the canes we decided to leave standing. Ideally, they will grow and carry 2-3 bunches of grapes and 10-12 leaves to support them. Because of the excessive vigor, many canes will grow additional "lateral" canes at each leaf joint – and if not removed, each of these lateral canes would, in turn, grow to carry second-tier bunches and leaves. So we need to pinch off all laterals at each leaf joint before they get big. Doing so opens up the canopy for air circulation (which helps prevent mildew), and it forces the vines to channel their energy to the primary grape clusters.

While eliminating laterals, we continue with positioning the canes between the upper two guide wires. We also remove the first 2-3 leaves on each cane (up to and including the leaf opposite the lower bunch) to expose the grape bunches to direct sunlight. It promotes tannin development and prevents leaves from getting tangled into bunches. The pictures on the right show a typical "before and after" on a single vine.

We start hedging when 50% of the canes have grown more than 2 feet beyond the top guidewire. Lateral removal is critical for effective hedging. If laterals had not been removed before, a topped cane would accelerate the growth of the laterals at each leaf node, and these laterals would grow secondary grape bunches. The consequence would be a very dense canopy with grapes of uneven maturity.

We start lateral removal and leaf thinning around mid-May during full bloom. It is very labor-intensive, taking me about 100 hours for the entire vineyard in two rounds. Hedging is a continuing effort because shorter canes continue to grow, passing the ones we topped earlier.

Grape & Cane Thinning

The goal of grape thinning is to optimize the quality of grape bunches that the vines should be capable of bringing to full maturity. The final quality depends on the current state of the bunches and the capacity of the vines to mature them fully. Soil nutrition and the weather, year to date, define the volume and quality of bunches available now; the age of the vines and the arms establishes the number of grapes the vine can expect to fully mature, assuming average weather patterns for the remainder of the year.

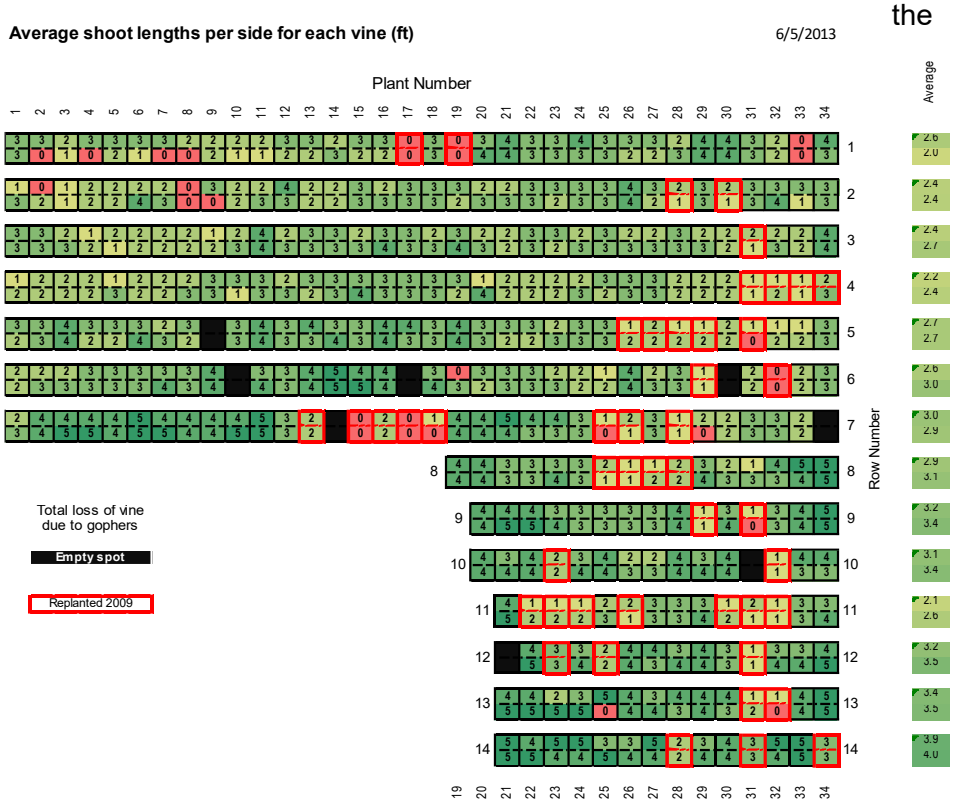
Our target is to harvest 1.2 tons of grapes for our wine production and sell the remaining crop to a local winery. We estimate that in a great season with mature, healthy vines throughout, the vineyard should be able to produce about 2 tons, or 2.7 tons/acre, of high-quality grapes. In an average year, we are happy with a harvest of 1.2 to 1.6 tons/acre. Eye-balling the current crop load and comparing that estimate to the target significantly influences how aggressive we are at dropping bunches at this time.

Our general rules for dropping bunches and canes are:

1. We drop bunches which have reduced or mediocre fruit set (i.e., not well developed or damaged fruit)
2. We drop all bunches on canes that are now less than 1 foot long (i.e., the cane would not have the capacity to mature the fruit). We also cut out the weaker of two canes on a node if either of them is less than a foot long (the idea is to focus the vine's energy on growing what is needed next year).
3. We drop all bunches except the best developed on canes which are now between 1 and 2 feet long (i.e., the cane would not be able to mature more than one bunch)
4. We drop all bunches except the two best developed on canes which are now over 2 feet long, except for extremely strong canes, which are allowed to carry a max of 3 bunches if those bunches are well separated in space.
5. We cut off pronounced wings on all remaining bunches (berries on wings tend to mature later rest of bunch)

These rules have room for interpretation. The interpretation depends on how much tonnage we want to drop.

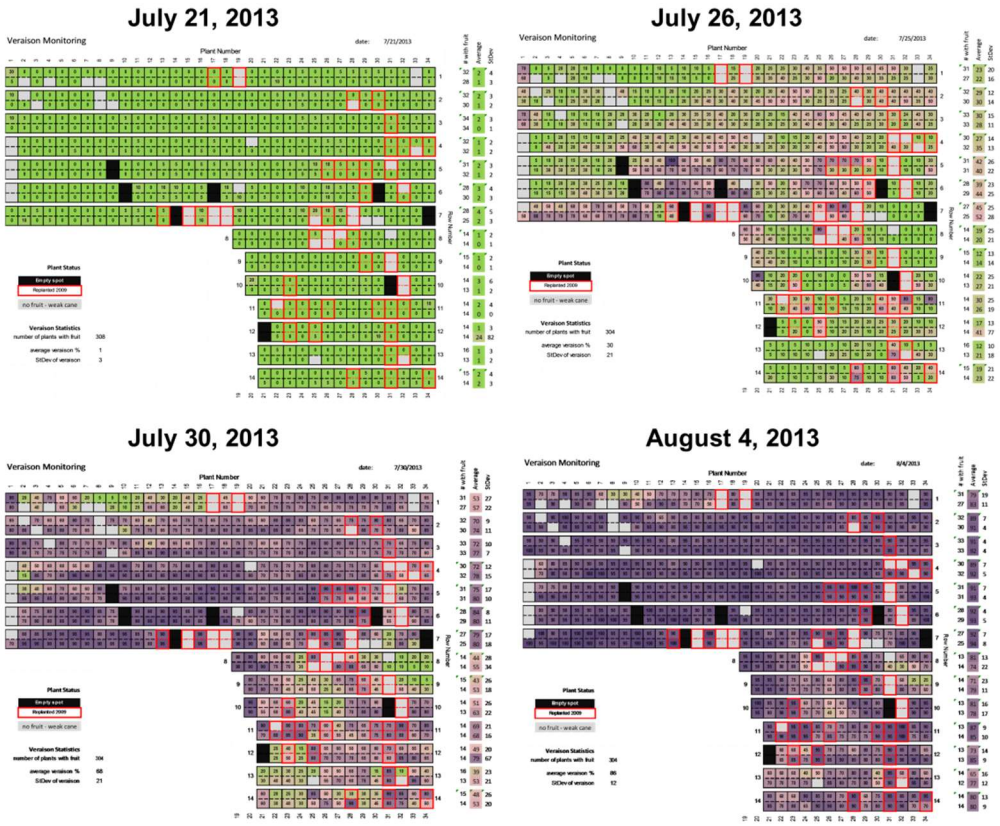
The picture illustrates the health of the vineyard in early June 2013. It shows the average lengths of the canes for each side of each plant. Clearly, the short canes are primarily on the young vines (which were replanted a few years ago due to gopher damage) or on the new arms (which grew to replace the Eutypa cut-outs)



Cluster Thinning

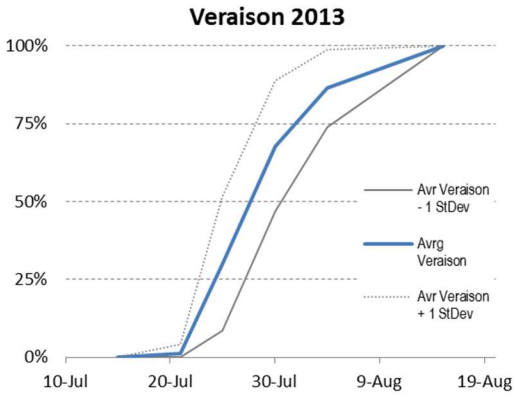
At Veraison, the grape berries turn from green to purple-blue as anthocyanins replace chlorophyll. This turning of color provides an excellent opportunity to compare the maturity of the grapes across the vineyard. Ideally, Veraison should happen for all grapes simultaneously, but it does not – some turn color early, others turn color late. Because we will pick the matured grapes all at the same time, we end up picking grapes at different levels of maturity. To narrow the range of final maturity at picking time, it is advisable to drop the first 5-10% of bunches that have turned color and drop the last 5-10% of bunches a couple of weeks later that are still green. Doing so should narrow the range of grape maturity left on the vine. This assumes that the early birds would not slow down their development, and the late bloomers would not accelerate their maturing and catch up.

The following graphics show the progression of Veraison in the vineyard from July 21 to August 4, 2013. On July 20, only 1% of berries show blue coloring. By July 26, that percentage increased to 20%. By July 30, 60% of berries have turned, and by August 4, the level of Veraison has reached 86% on average.

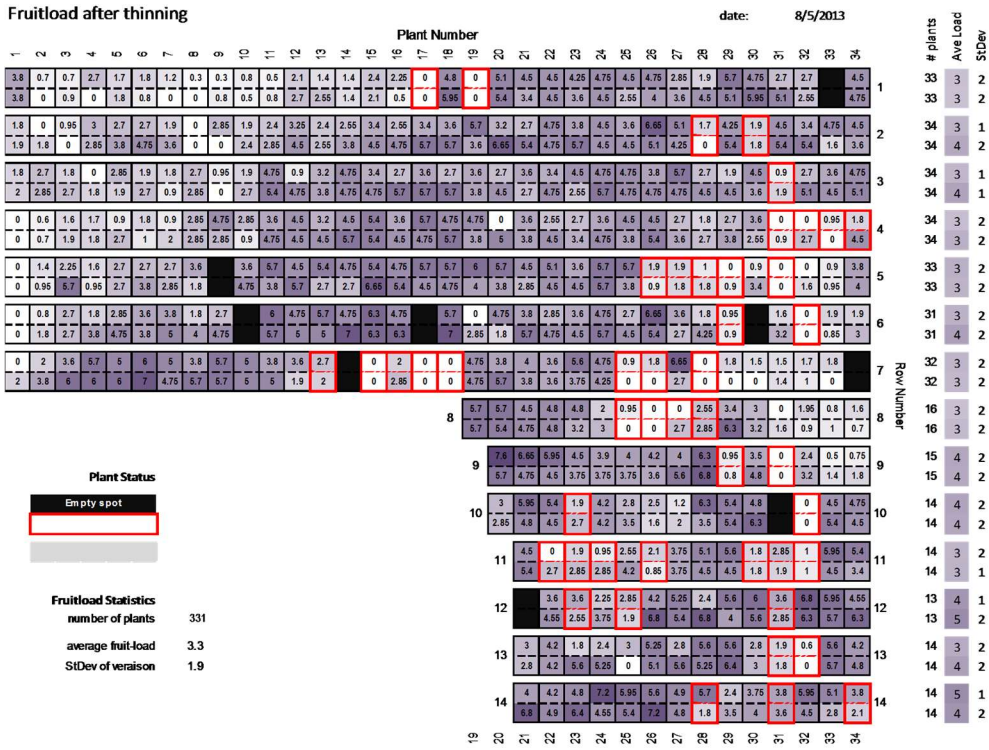


Note that the development is uneven: the short rows and the east side of row 1 lag behind in development for about five days. One potential remedy for next year is to start pruning the short rows first, before long rows (in 2013, we pruned from south to north).

The graphic on the right shows how Veraison progressed in 2013. The mid-point at 50% Veraison happened around July 29.



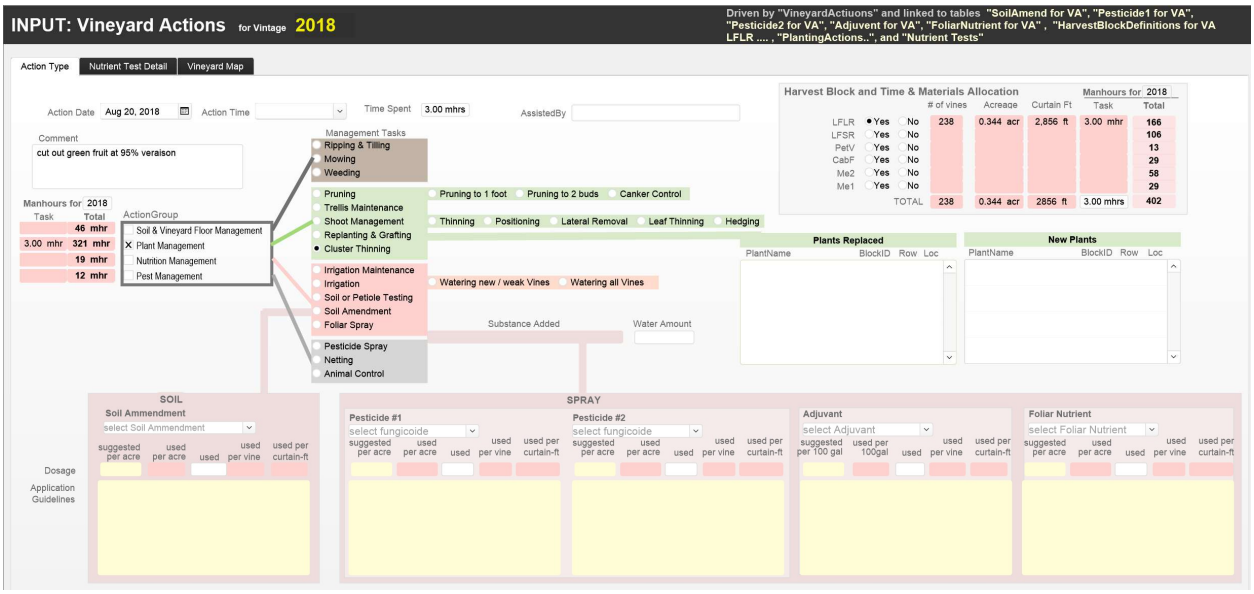
With Veraison 90% complete, we start cutting out the remaining green grapes – green thinning to get more even maturity for the remaining grapes at harvest time. The general rule is to cut out all bunches, which at this point show no sign of Veraison. The following graphic shows the crop load on each vine after grape thinning. The loads are graded 0 (for no grapes on the vine) to 8 (full grape load).



Interesting article on crop thinning and overcropping: http://www.enologyinternational.com/yield/yieldvsq3.html

Data Management

We record all plant management tasks in the database through the “INPUT: VineyardActions” – Layout. Other than the date of the activity and the time it took to complete, we record no data except occasional commentaries. These tasks do not lend themselves to a lot of measurements. Here is a screenshot of the layout recording cluster thinning for August 20, 2018, in the short rows of the lower vineyard. Upon entry, the layout shows aggregate person-hours spent on the vineyard blocks and for the task type.



Previous page: Soil & Vineyard Floor Management

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Next Page: Nutrition Management

Last updated: May 2, 2021

Nutrition Management

This page describes how we manage vine nutrition in six sections:

- **Irrigation System Management** deals with annual maintenance and ongoing adoption of new technologies
- **Irrigation** describes when we irrigate and how
- **Nutrition Requirements** deals with measuring the available nutrients in the ground and the vines.
- **Soil Amendment** deals with dispersing nutrients to the soil
- **Foliar Sprays** describes how we spray nutrients directly on the plant leaves
- **Data Management** explains what we record and report on

The following link leads to an excellent general presentation on grapevine nutrition: http://www.uvm.edu/~fruit/grapes/gr_horticulture/GrapevineNutrition.pdf. Our current approach to nutrition management is still very amateur. We irrigate when the plants look stressed. We send soil and plant samples to third-party laboratories to test nutrition deficiencies, but we are not yet confident how to interpret the results and take corrective action. We amend the soil with fertilizers, and we spray nutrients onto the leaves based on recommendations from consultants and experienced vineyard managers.

Irrigation System Management

Irrigation systems are complex and fragile. They require a fair amount of upkeep because of earth movements and erosion, interference from animals, general wear and tear, and evolving technologies. There is a never-ending effort to use less water and be more efficient. In our region, the bulk of necessary water comes from winter rain stored in the clay soils. Our long-term goal is to supply each vine with the estimated amount of water it needs without wasting any in evaporation from the vineyard floor or underground drainage. As each plant sits in slightly different soils, has different exposure to sun and wind, and varies in size and maturity – the ideal solution is to measure each plant's requirement in near real-time and regulate the supply accordingly. This is not yet economically feasible but should be achieved within the next ten years at an investment of less than $10 per vine. In the meantime, we estimate the demand and regulate the supply manually by vineyard block.

Irrigation

As a general rule, mature vineyards need little irrigation. The vines' root system should reach deep enough to get to the required moisture. Excess irrigation of mature vineyards prevents the roots from growing deep and makes the grapes watery. Young vines need irrigation for the first three years after planting because they only have shallow roots – that is the principal reason for the drip irrigation system built into the trellis.

There are four exceptions to the rule:

1. We irrigate the vineyard thoroughly once right after harvest when the summer heat has stressed the vines and now need to start focusing on growing the roots
2. We irrigate the vineyard a few days before extreme heat waves when we expect temperatures to exceed 95 F for more than a day. This assumes we get good weather forecasts and can supply the plant ahead of time with extra water reserve.
3. We irrigate the vineyard in the final days of berry maturation when we detect an imbalance between sugar levels and phenolic maturity of the grapes. In hot years, the sugars accumulate faster, and the maturity of the skins and seeds may lag. In this instance, intermittent irrigation during the last weeks before picking allows grapes to mature fully, prevents premature shriveling, and keeps the sugar levels in check.
4. We irrigate new replacement vines for the first three years every 1-2 weeks. This has to be done plant by plant. We used to use 5-gallon buckets, with a 1/16th-inch hole at the bottom, so they release water only very slowly. The buckets were placed next to each young vine and manually filled by a hose. The picture shows the setup. Since it is time-consuming to refill the buckets by hose every week, we added a second irrigation line controlled only to water the new plants. That line is on a timer for automatic irrigation.

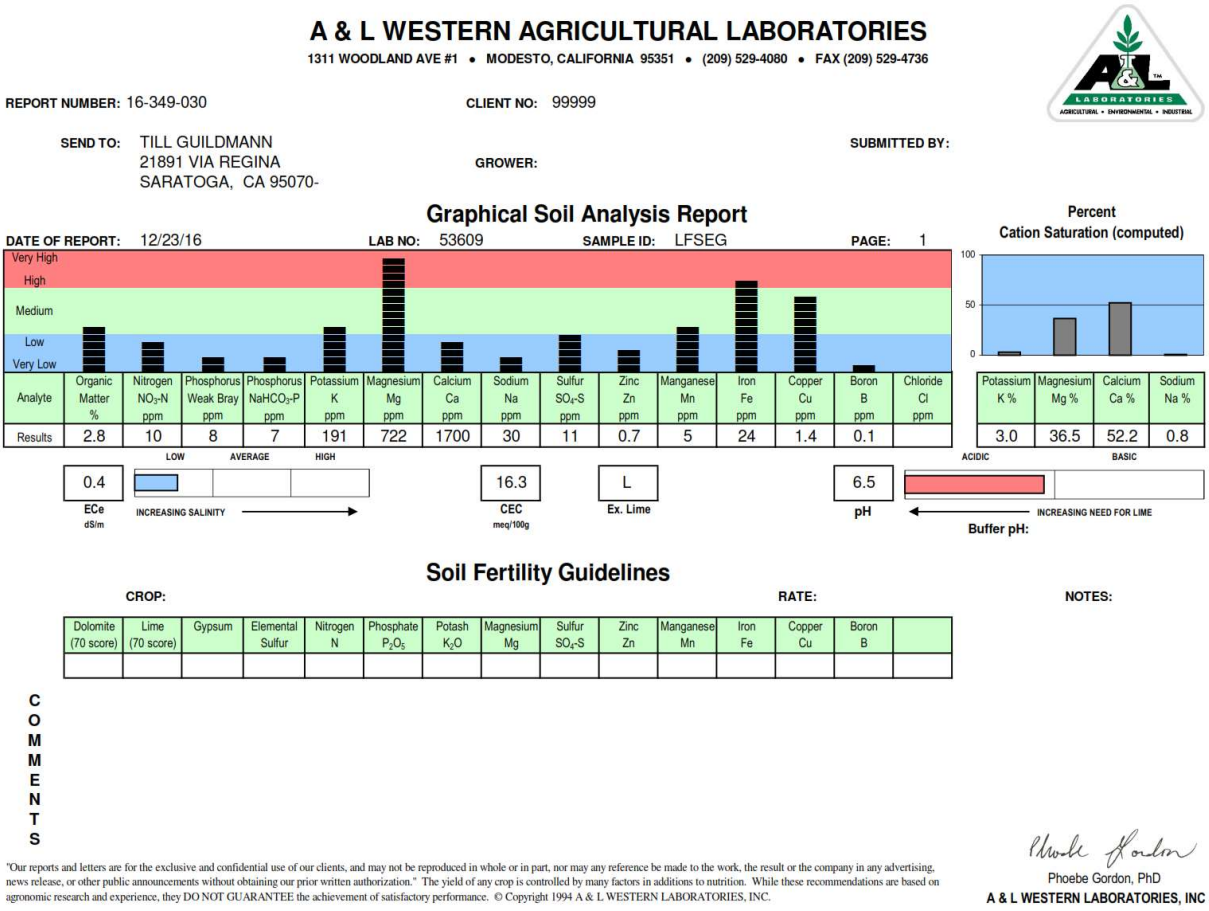
Nutrition Requirements

There are three basic approaches to understanding whether plants need nutrition supplements:

- Visual inspection: looking for visual clues signaling nutritional deficiencies or excesses.
- Soil Testing: measuring the availability of nutrients in the soil
- Petiole testing: measuring the nutrients taken up from the soil and stored in the plant

Experienced farmers and vineyard managers can look at a plant and identify nutritional deficiencies. Typical clues are the abnormal coloration of leaves or stunted growth.

Every few years, we test the soils for their nutrient and trace metals. We take about a dozen soil samples 3 to 12 inches from the surface in each block and mail them to a testing laboratory. Testing laboratories provide good instructions on how to take the samples and how to send them in. A week later, we get the results by email. Following is a typical soil test report.



A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 16-349-030 CLIENT NO: 99999

SEND TO: TILL GUILDMANN
21891 VIA REGINA
SARATOGA, CA 95070-

GROWER:

SUBMITTED BY:

Graphical Soil Analysis Report

DATE OF REPORT: 12/23/16 LAB NO: 53609 SAMPLE ID: LFSEG PAGE: 1

Very High / High / Medium / Low / Very Low

Analyte	Organic Matter %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Chloride Cl ppm
Results	2.8	10	8	7	191	722	1700	30	11	0.7	5	24	1.4	0.1	
			LOW	AVERAGE	HIGH										

Percent Cation Saturation (computed)

Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
3.0	36.5	52.2	0.8
		ACIDIC	BASIC

ECe dS/m	CEC meq/100g	Ex. Lime	pH
0.4	16.3	L	6.5

INCREASING SALINITY →

← INCREASING NEED FOR LIME

Buffer pH:

Soil Fertility Guidelines

CROP: RATE: NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	

COMMENTS

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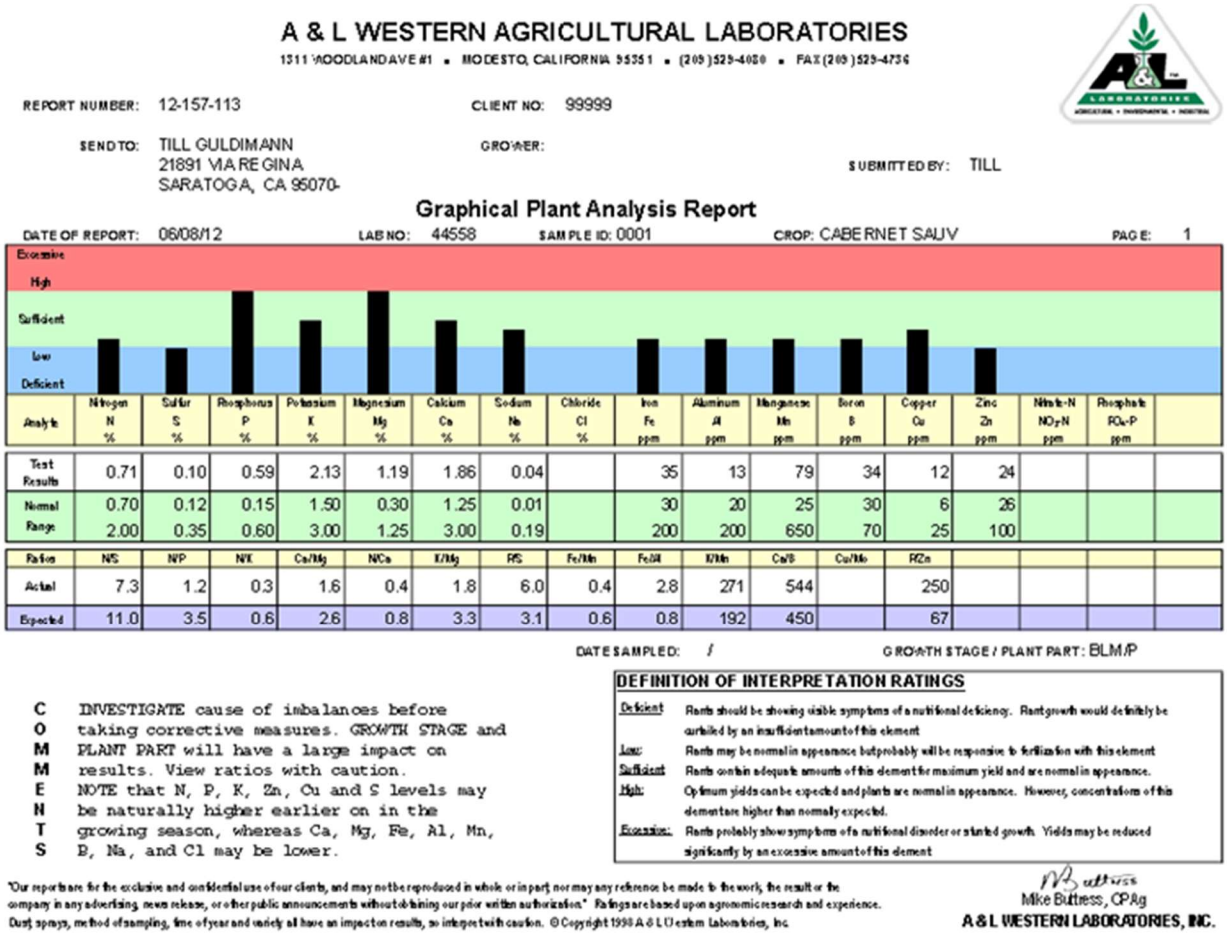
Phoebe Gordon, PhD
A & L WESTERN LABORATORIES, INC

Testing soils is easy; interpreting the results and taking appropriate action is far more complex. Each soil type has vastly different characteristics for water and chemical extraction. The challenge is to understand how the plant's roots interact with soil types under varying humidity and temperature conditions. Furthermore, the soil characteristics can vary greatly even over short distances. To complicate things even further, fertilizers take the better part of a season to sink into the ground and distribute, and the plants may take more than a year to extract and react fully.

We have used an excellent consultant (http://www.growyoursoil.org) to interpret soil tests before planting when we added significant amounts of soil amendments to pastures (see Soil Analysis & Amendments on the Site Preparation page).

The difficulties in interpreting soil analysis results and correcting with fertilizers have led to an alternative approach: analyze the plant tissues instead. We collect around 50 petioles (stems of leaves) from plants in each block and mail them to a testing laboratory. Following is a sample of a resulting plant analysis report.



A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209)529-4080 • FAX (209)529-4736

REPORT NUMBER: 12-157-113 CLIENT NO: 99999

SEND TO: TILL GULDIMANN
21891 VIA REGINA
SARATOGA, CA 95070-

GROWER:

SUBMITTED BY: TILL

Graphical Plant Analysis Report

DATE OF REPORT: 06/08/12 LAB NO: 44558 SAMPLE ID: 0001 CROP: CABERNET SAUV PAGE: 1

Excessive
High
Sufficient
Low
Deficient

Analyte	Nitrogen N %	Sulfur S %	Phosphorus P %	Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %	Chloride Cl %	Iron Fe ppm	Aluminum Al ppm	Manganese Mn ppm	Boron B ppm	Copper Cu ppm	Zinc Zn ppm	Nitrate-N NO_3-N ppm	Phosphate PO_4-P ppm	
Test Results	0.71	0.10	0.59	2.13	1.19	1.86	0.04		35	13	79	34	12	24			
Normal Range	0.70 2.00	0.12 0.35	0.15 0.60	1.50 3.00	0.30 1.25	1.25 3.00	0.01 0.19		30 200	20 200	25 650	30 70	6 25	26 100			

Ratios	N/S	N/P	N/K	Ca/Mg	N/Ca	K/Mg	P/S	Fe/Mn	Fe/Al	K/Mn	Ca/B	Cu/Mo	P/Zn				
Actual	7.3	1.2	0.3	1.6	0.4	1.8	6.0	0.4	2.8	271	544		250				
Expected	11.0	3.5	0.6	2.6	0.8	3.3	3.1	0.6	0.8	192	450		67				

DATE SAMPLED: / GROWTH STAGE / PLANT PART: BLM/P

C O M M E N T S: INVESTIGATE cause of imbalances before taking corrective measures. GROWTH STAGE and PLANT PART will have a large impact on results. View ratios with caution. NOTE that N, P, K, Zn, Cu and S levels may be naturally higher earlier on in the growing season, whereas Ca, Mg, Fe, Al, Mn, B, Na, and Cl may be lower.

DEFINITION OF INTERPRETATION RATINGS

Deficient:	Plants should be showing visible symptoms of a nutritional deficiency. Plant growth would definitely be curtailed by an insufficient amount of this element
Low:	Plants may be normal in appearance but probably will be responsive to fertilization with this element
Sufficient:	Plants contain adequate amounts of this element for maximum yield and are normal in appearance.
High:	Optimum yields can be expected and plants are normal in appearance. However, concentrations of this element are higher than normally expected.
Excessive:	Plants probably show symptoms of a nutritional disorder or stunted growth. Yields may be reduced significantly by an excessive amount of this element

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

We then correct the shortages of nutrients in the tissue by spraying chemicals directly onto the leaves — not a very natural remedy, but quicker and more effective. For the primary nutrients (Nitrogen, Phosphorus, and Potassium), foliar sprays are only a band-aid; for micronutrients (iron, zinc, boron, manganese), they are the preferred application method.

Soil Amendments & Fertilizers

The primary nutrients (N, P, and K) can be sourced from inorganic (usually mined) or organic materials (collected on farms). Inorganic materials such as gypsum (Calcium Sulfate) or lime (Calcium Oxide) release nutrients faster than organic materials such as compost or manure. So, the challenge is to understand how much of which component needs to be added and how long it takes the plants to absorb it before it is washed away, evaporates, or disappears otherwise. Note that the excessive addition of nitrogen ends up in the groundwater and is a significant source of pollution (see https://www.cdfa.ca.gov/Is/ffldrs/frep/pdfs/GrapeBrochureWeb.pdf for a good summary on nitrogen application in vineyards). Another good source of general information is the International Plant Nutrition Institute (http://www.ipni.net/). The best summaries of fertilizers and soil amendments I have come across are from the University of Maryland https://extension.umd.edu//sites/extension.umd.edu/files/_images/programs/hgic/Publications/HG42_Soil_Amendments_and_Fertilizers.pdf and the Colorado State University: http://extension.colostate.edu/topic-areas/yard-garden/choosing-a-soil-amendment/.

We don't yet have a solid program for applying fertilizers and soil amendments. Instead, we rely on recommendations from consultants following soil tests or from experienced vineyard managers on an ad-hoc basis. Following is a list of what we have used in the past:

- YaraVera Urea (46-0-0)
- Mini-prilled Calcium Sulfate from Art Wilson
- Mono-Ammonium Sulfate from Simplot (11-52-0)
- Greenbelt Fertilizer from Romeo (25-14-14)
- Potassium Sulfate from Yara (0-0-50)
- Rapid release limestone from ArtWilson
- Maximo 360 Zinc Sulfate
- Ferreous Sulfate from EcoFusion
- SuperIron 11% from Simplot
- Sodium Borate / Solubor from U.S. Borax
- Manganese from PrinceMinerals
- Bonemeal from Kellog Garden
- Mushroom compost from a nearby mushroom farm

- Horse manure from a nearby farm
- Hydroprill 20-20-20. On the day after harvest, we put one spoonful of Hydropril under each dripper and irrigate for 4 hours (recommendation by Rick Berg)

There is much room for improvement.

Foliar Sprays

With foliar sprays, we apply nutrients directly to the leaves. Most of the time, we combine foliar sprays with Pesticide Sprays (see next page). We currently use:

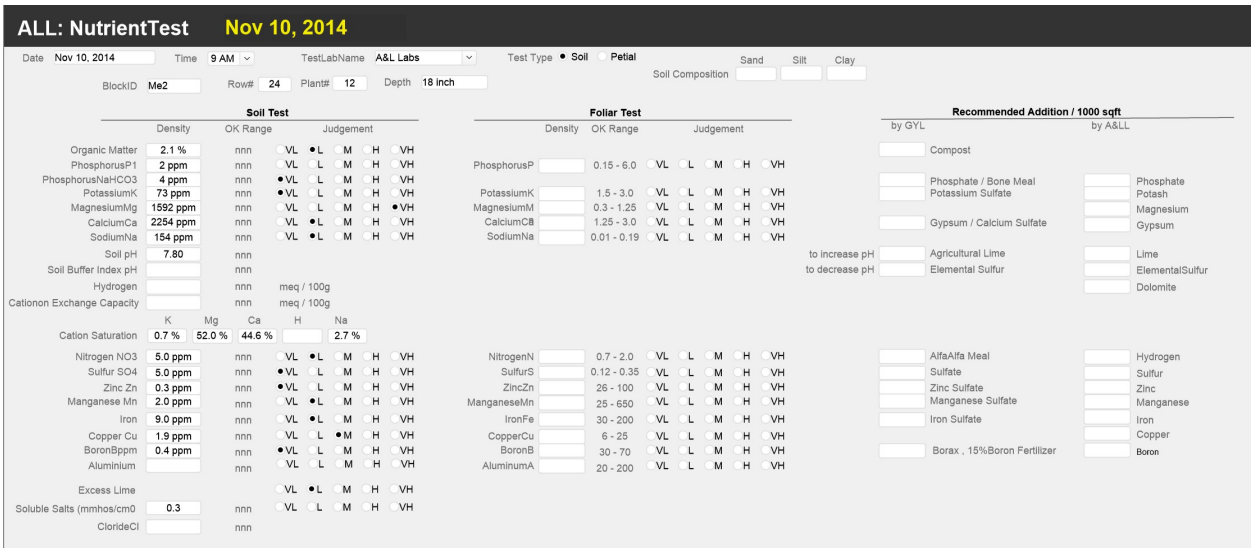
- Eleanor's VF-11 (Nitrogen 0.15%, Phosphate 0.85%, Soluble Potash 0.55%): general plant food for foliar feeding.
- LIG-Calcium+B: Calcium Lignosulfonate: Foliar Nutrient to add Calcium & Boron. to promote flowering and even fruit set; increases fungal resistance.
- LIG-Trace: Complexed Lignosulfate: Foliar Nutrient to add trace elements to sulfate-based sprays
- CropBiolife-O: Foliar Spray containing naturally occurring flavonoids that stimulate the biosynthetic pathways

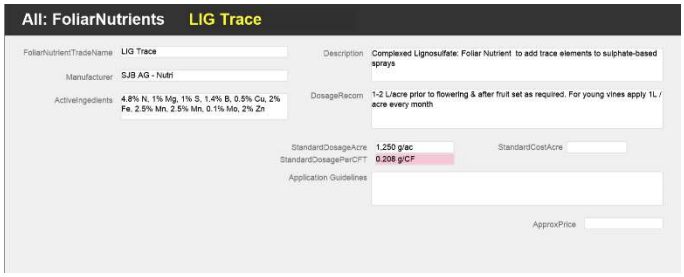
Data Management

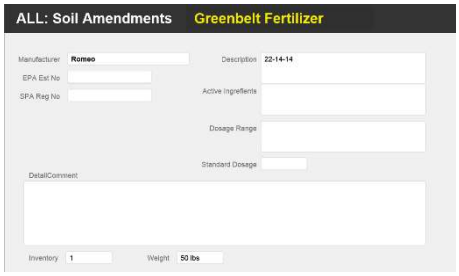
There are four data management tables and related layouts covering nutrition management

- NutrientTest is used to record results from soil tests and foliar tests as well as recommendations for soil enhancement based on the test results
- SoilAmendments contains the descriptions of soil amendments that are currently in inventory and used
- FoliarNutrients contains the descriptions of foliar sprays currently in inventory and used
- The "INPUT: VineyardActions "-Layout is used to record nutrition management tasks

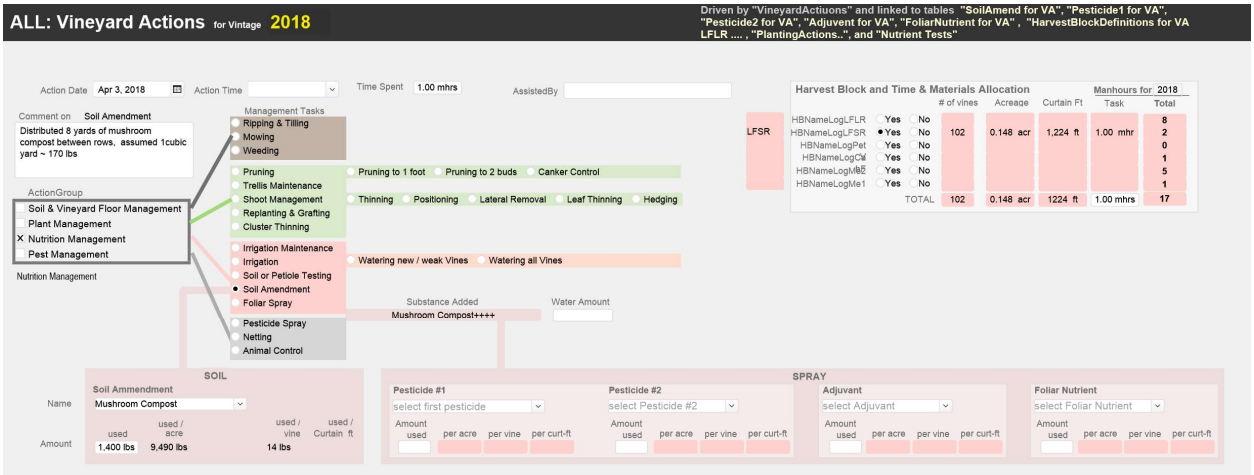
We use the "ALL: NutrientTests"-Layout to input results from foliar tests. The screenshots show the results from a foliar test on Nov 10, 2014, in the Me2 block







We use the “ALL: VineyardActions”- layout to record the addition of a soil amendment. This screenshot shows the addition of 1,400 lbs of mushroom compost to the LFLR block in April 2018



Previous page: Plant Management
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Next Page: Pest Management
Last updated: May 3, 2021

Pest Management

This page describes how we contain pests, i.e., protect from and eradicate diseases and protect from animals that tend to damage grapevines. The best starting point for any farmer in California is the website managed by the University of California on Integrated Pest Management. Here is the link to the section covering grapevines: http://ipm.ucanr.edu/PMG/selectnewpest.grapes.html. Other valuable websites are:

- The listing of other Pest Management Websites: http://ipm.ucanr.edu/GENERAL/links.html
- The U.S. National Pesticide Information Center: http://npic.orst.edu/NPRO/
- The California Dept of Pesticide Regulation: https://www.cdpr.ca.gov/docs/label/labelque.htm
- The EPA Pesticide Product and Label System: https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1
- The OMRI database of organic products: https://www.omri.org/omri-lists

Also, the TTU Vineyard Advisor application from the Texas Tech University is a handy tool for mobile devices. It can be downloaded free from the Apple Store or the Google Play store

Because there is so much good and well-organized information about pest management readily available on the web, we concentrate here on the practical aspects and what we do about:

- Pesticide Sprays: what we spray and how
- Animal Control: how we keep damaging vertebrates out of the vineyard.
- Netting: how we protect the maturing grapes from birds and yellow jackets
- Data Management: how we record what we do

Pesticide Spray

In the beginning, we used to spray with a manually operated back sprayer, then we switched to a tank with a pump and long hose, and finally, we graduated to a Gearmore Venturi Air sprayer (http://www.gearmore.com/gearmore/orderportal/catalog_presentation/by_group/0/163/0/0/0/0/0) attached to a tractor. In the process, we cut down application times from 5 hours to half an hour!

The California Department of Food & Agriculture strictly controls the application of pesticides and requires an application license. This license is required to purchase pesticides. We apply annually as a Private Applicator for an Operator Identification Number. After each application, we submit an Agricultural Pesticide Use Report on the Agricultural Commissioner's website.

The best use of pesticides is preventative; once a disease has infected a vineyard, only eradicants can help, and they tend to be less wholesome. Prevention is like paying insurance premiums; if you don't get hit by a disease, you never know whether you needed it. In the early 2000s, we sprayed aggressively; then we relaxed and got hit by mildew and canker diseases. So now, we are more diligent and spray following an annual program, keep better records and, when possible, use organic products.

Disease	Dormant	Budbreak	Full bloom	Pre-close	Veraison	Preharvest/Postharvest[5]
Botryosphaeria canker (Bot canker)	+++	----	----	----	----	----
Botrytis Bunch Rot	+++[2]	----	+++[1]	+++[1]	+++[1]	+++[1]
Brown spot	----	----	----	+++	+++	+++
Dead arm	+++	+++	----	----	----	----
Downy mildew	----	+++	+++	----	----	----
Esca (Black measles)	+++[2]	----	----	----	----	----
Eutypa Dieback	+++	----	----	----	----	----
Powdery mildew	+++[2]	+++[3]	+++[3]	+++[4]	----	----
Phomopsis	+++	+++	----	----	----	----
Summer bunch rot (sour rot)	----	----	----	----	+++[1]	+++[1]

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Apply only if rain is forecasted.

[2] Use 10 gallons lime sulfur per acre in at least 100 gallons water.

[3] Apply bud break and full bloom treatments every year.

[4] Apply as needed (a disease risk assessment model is available to help determine need for spray).

[5] Preharvest treatments for postharvest decay control.

The table on the right (from the IPM website http://ipm.ucanr.edu/PMG/r302902111.html#EFFICACYCONV) shows the suggested timing of pesticide applications for the prevention of specific diseases depending on the development stage of the vine. We are primarily concerned with Powdery Mildew, Dead Arm, and Eutypa Dieback. The following two tables (from the same website) show the efficacy of different commercially available pesticides against various diseases.

FUNGICIDE EFFICACY – CONVENTIONAL CHEMISTRY

Fungicide	Resistance risk (FRAC#)[1]	Powdery mildew	Downy mildew	Rot		Phomopsis cane and leaf spot	Eutypa dieback	Bot Canker	Dead Arm (*Phomopsis* sp.)
				Botrytis bunch rot	Summer rot				
Abound	high (11)[2]	++++	++++	+	----	+++	NR	----	----
Flint[3]	high (11)[2]	++++	+++	++	++	++	NR	----	----
Inspire Super	medium (3/9)	++++	----	++++	++	----	NR	NR	NR
Kenja	high (7)	++++	NR	NR	NR	NR	NR	NR	NR
Luna Experience	medium (3/7)	++++	----	++++	++	----	NR	NR	NR
Luna Tranquility**	medium (7/9)	++++	----	+++	++	----	NR	NR	NR
Merivon (vine+raisin)	medium (7/11)	++++	----	++++	++	----	NR	NR	NR
Mettle	high (3)	++++	----	----	+	----	+++	----	----
Orius, Tebucon, Toledo, Tebuconazole, Elite, (Tebuzol)**	high (3)	++++	----	++	++	----	NR	----	----
Pristine	medium (7/11)[2]	++++	++++	++++	+++	+++	NR	----	----
Procure	high (3)	++++	----	----	----	----	NR	----	----
Quadris Top	high (3/11)	++++	+	++	++	++	NR	----	----
Quintec	high (13)	++++	----	----	----	----	NR	----	----
Rally	high (3)	++++	----	----	----	----	+++	++	++
Rally+Topsin-M[5]	high (1+3)	++++	----	----	----	++++	++++[6]	++++	++++
Revus Top	medium (3/40)	++++	++++	++	++	++	NR	----	----
Rhyme	high (3)	++++	----	----	----	----	NR	----	----
Rubigan**, Vintage**	high (3)	++++	----	----	----	----	NR	----	----
Sovran	high (11)[2]	++++	++++	++	++	++++	----	NR	++++
Sulfur	low (M2)	++++	----	----	----	----	NR	----	----
Topsin-M, T-Methyl, Incognito	high (1)[2]	++++	----	++	++	+	++++	++++	++
Torino	high (U6)	++++	----	----	----	----	----	----	----
Vivando	high (U8)	++++	----	----	----	----	----	----	----
Luna Privilege	High (7)	+++	----	+++	+	----	++	----	----
Bayleton**	high (3)	++	----	----	----	----	NR	----	----
Copper	low (M1)	++	+++	++	+++	----	----	----	----
Elevate	high (17) [2]	++	----	++++	++	----	NR	----	----
Ph-D	medium (19)	++	----	+++	+++	ND	NR	----	----
Scala	high (9)[2]	++	----	++++	++	----	NR	----	----
Switch	low (9/12)	++	----	++++	+++	----	----	----	----
Vangard	high (9)[2]	++	----	++++	++	----	NR	----	----
Botran	medium (14)	----	----	+++	----	----	----	----	----
Captan	low (M4)	----	+	+++	+++	+++	NR	----	----
CaptEvate**	low (M4/17)	----	+	+++	+++	+	----	----	----
Dithane, Manzate, Penncozeb	low (M3)	----	----	++	----	+++	----	----	----
Presidio**	high (43)	----	++++	----	----	----	----	----	----
Revus	high (40)	----	++++	----	----	----	----	----	----
Ridomil Gold, (Mefenoxam**)	high (4)	----	++++	----	----	----	----	----	----
Rovral, Iprodione, Nevado	low (2)	----	----	+++	----	----	----	----	----
Ziram	low (M3)	----	++	+	+	+++	----	----	+++
Laguna	high (3)	ND	ND	ND	ND	ND	ND	ND	ND
Aprovia*	medium (7/11)[2]	NR	NR	NR	NR	NR	NR	NR	NR
Rovral + Oil[4]	low (2)	NR	----	++++	----	----	NR	----	----
Oso	medium (19)	NR	----	+++	+++	ND	NR	----	----

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective; ND = no data and NR = not recommended.
*** Registration pending in California.**
**** Not registered, label withdrawn or inactive in California.**
***** Registered only on wine grapes in California.**

GRAPEVINE: FUNGICIDE EFFICACY – SOFT CHEMISTRY (BIOLOGICAL AND NATURAL PRODUCTS)

Fungicide	Resistance risk (FRAC#)[1]	Powdery mildew	Downy mildew	Bunch rot		Phomopsis cane and leaf spot	Eutypa dieback	Bot Canker	Dead Arm (*Phomopsis* sp.)
				Botrytis	Summer				
Cinnacure	low	+++	----	----	----	----	----	----	----
Elexa**	low	+++	----	----	----	----	----	----	----
Fracture	low	+++	----	++	----	----	----	----	----
JMS Stylet oil4	low	+++	----	+++	++	----	NR	----	----
Kaligreen	low	+++	----	----	----	----	----	----	----
Milstop	low	+++	----	----	----	----	----	----	----
Purespray	low	+++	----	----	----	----	----	----	----
Regalia	low	+++	-----	----	----	----	-----	----	----
Serenade	low (44)	+++	----	++	+	----	----	----	----
Sonata	low	+++	----	++	NR	----	----	----	----
Taegro**	low	+++	----	++	+	----	----	----	----
Vintre	low	+++	----	----	----	----	----	----	----
Actinovate	low	++	-----	----	----	----	-----	----	----
Employ*	low	++	----	----	----	----	----	----	----
HiPeak*	low	++	----	----	-----	-----	-----	----	----
Prev-am*[4]	low	++	----	----	----	----	++	----	----
Sporan	low	++	----	----	----	----	----	----	----
Timorex*[4]	low	++	----	----	----	----	----	----	----
VigorCal*	low	++	----	----	----	----	----	----	----
VigorK*	low	++	----	----	----	----	----	----	----
Double Nickel	low	+	----	+	NR	----	----	----	----
Sporatec	low	+	----	----	----	----	----	----	----
B-Lock*	low	----	---	----	-----	-----	++++	++	NR
Vitiseal	low	----	----	----	----	----	++++	----	----
Botector	low	ND	----	+	----	----	----	----	----

*** Registration pending in California.**
**** Not registered, label withdrawn or inactive in California.**
Rating: ++++ = excellent and consistent, +++ = good and reliable under low to medium disease pressure (high disease pressure will result in reduced efficacy with a rating of +/++), ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective; and NR = not recommended.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action Group number.

[2] To reduce the risk of resistance development, start treatments with a fungicide with a multi-site mode of action; rotate or mix fungicides with different mode of action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications/season.

[3] Causes severe phytotoxicity on Concord grape.

[4] Phytotoxic if used within 2 weeks of Captan or sulfur.

[5] Tank mixture applied post-pruning (dormant or delayed dormant).

[6] Apply at two week intervals during rain events.

Our spray program is still evolving as we only started to rationalize our approach in late 2018; before, we sprayed by the seats of our pants more or less following external advice or reacting to infestations.

Our current guidelines are:

- Start with a dormant spray in mid-February and follow up, after Bud Break, with subsequent sprays every 2 to 3 weeks through Veraison
- We prefer natural/biological products over chemical products (see tables above)
- Alternate among products with different modes of action (FRAC#) to reduce the chance of buildup of natural resistance (see table below)
- Follow best practices for protecting bees (see http://ipm.ucanr.edu/mitigation/protect_bees.html) and consider bee precaution pesticide ratings (https://www2.ipm.ucanr.edu/beeprecaution/)
- Adjust suggested spray volumes per acre to the size of the canopy in each block (as measured by curtain feet)
- Enhance the efficiency of the applications with adjuvants where recommended (Adjuvant is a broad term describing any additive to a spray tank that enhances pesticide activity. Examples of adjuvants are surfactants, spreader stickers, crop oils, anti-foaming materials, buffering agents, and compatibility agents).
- Combine Pesticide spray with Nutrient/Foliar spray when required

- Establish a baseline “Spray Program” each winter and adjust it according to weather conditions and field observation during the season.

The following screenshot of the website http://ipm.ucanr.edu/PMG/r302900211.html shows the general properties of fungicides used in grapes

Common name (example trade name)	Chemical class	Activity	Mode of action (FRAC Group No.[1])	Resistance potential	Comments
azoxystrobin (Abound)	QoI[5]	contact, systemic[2]	single-site (11)	high	
Bacillus pumilis (Sonata)	microbial	contact	various (44)	low	
Bacillus subtilis (Serenade)	microbial	contact	various (44)	low	
captan	phthalamide	contact	multi-site (M4)	low	highly toxic to honey bee larvae
copper	inorganic	contact	multi-site (M1)	low	
copper hydroxide	inorganic	contact	multi-site (M1)	low	
copper sulfate	inorganic	contact	multi-site (M1)	low	
cyflufenamid (Torino)	phenylacetamide	–	unknown (U6)	high	
cyprodinil (Vangard)	anilinopyrimidine	mostly contact, slightly systemic	single-site/ single-site (9 / 12)	high	
cyprodinil / fludioxonil (Switch)	anilinopyrimidine and phenylpyrrole	contact, slightly systemic	single-site (9 + 12)	low to medium	
difenoconazole / azoxystrobin (Quadris Top)	DMI[3]-triazole and QoI[5]	systemic (local)	single-site/ single-site (3 / 11)	medium to high	
difenoconazole / cyprodinil (Inspire Super)	DMI[3] and anilinopyrimidine	contact, systemic	single-site/ single-site (3 / 9)	medium	
fenhexamid (Elevate)	hydroxyanilide	contact	single-site (17)	high	
fluopyram / tebuconazole (Luna Experience)	SDHI[6] pyridinyl-ethyl-benzamide and DMI[3]	contact, systemic	single-site/ single-site (7 / 3)	medium	
fungicidal soap (M-Pede)	inorganic salt	contact	–	low	
iprodione (Rovral)	dicarboximide	systemic (local)	single-site (2)	medium	
kresoxim-methyl (Sovran)	QoI[5]	contact, systemic[2]	single-site (11)	high	
mancozeb (Dithane)	dithiocarbamate	contact	multi-site (M3)	low	
mefenoxam (Kidomil Gold)	phenylamide	contact, systemic	single-site (4)	high	
metrafenone (Vivando)	benzophenone	contact	unknown (U8)	high	
myclobutanil (Rally)	DMI[3]-triazole	systemic (local)[2]	single-site (3)	high	
oil (JMS stylet oil)	mineral oil	contact	various (NC)	low	
potassium bicarbonate (Armicarb, Kaligreen, Milstop)	inorganic salt	contact	various (NC)	low	
pyraclostrobin / boscalid (Pristine)	QoI[5] and SDHI[6]	contact, systemic[2]	single-site/ single-site (11 / 7)	high	
pyrimethanil (Scala)	anilinopyrimidine	mostly contact, slightly systemic	single-site (9)	high	
quinoxyfen (Quintec)	aryloxyquinoline	contact	single-site (13)	medium	
sulfur	inorganic	contact	multi-site (M2)	low	highly toxic to native strains of western predatory mite *(Galen-dromus occidentalis)* and parasites.
tebuconazole (Elite)	DMI[3]-triazole	systemic (local)[2]	single-site (3)	high	
tetraconazole (Mettle)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
thiophanate-methyl (Topsin)	MBC[7]	systemic (local)	single-site (1)	very high	
trifloxystrobin (Flint)	QoI[5]	contact, systemic[2]	single site (11)	high	
triflumizole (Procure)	DMI[3]-imidazole	systemic (local)[2]	single-site (3)	high	
ziram	dithiocarbamate	contact	multi-site (M3)	low	

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one applic fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.
2 Generally considered to have systemic action based on performance data but has not been proven experimentally.
3 DMI = demethylation (sterol) inhibitor
4 SAR = systemic aquired resistance induced in host
5 QoI = quinone outside inhibitor (strobilurin)
6 SDHI = succinate dehydrogenase inhibitor
7 MBC = methyl benzimidazole carbamate

The Spray Program for 2018 is described in the Data Management section below.

In the past, we rotated through the following pesticides to prevent a range of diseases and a buildup of resilience (i.e., different FRAC numbers).

- **Champ** by Agtrol, US94.023.04. Copper hydroxide flowable agricultural fungicide to prevent powdery & downy mildew. 1-2.5 pts/acre
- **Thiolux** by Syngenta EPA Reg. No 100-1138. Dry flowable micronized sulfur to control powdery mildew and but-l, blister- & red spider- mite.
- **Microthiol** by United Phosphorus EPA Reg No 70508-187. Micronized wettable sulfur to control blister, bud & red spider mites, phomopsis, and powdery mildew 3-10 lbs/acre
- **Rally** 40WSP by Dow AgroSciences, EPA Reg no. 46719-410pp. Myclobutanil soluble powder is used to prevent antinacnose, black rot, and powdery mildew.
- **Rubigan** EC by Dow AgroSciences, EPA Reg No 62719-134. Systemic fungicide to control powdery mildew.

- **Pristine** by BASF, EPA No. 7969-199. Fungicide to target angular leaf spot, anthracnose, black & ripe rot, downey & powdery mildew, leaf blight, and phomopsis.
- **Stylet-Oil** by JMS FlowerFarms, EPA Reg No.65564-1. Paraffin oil for control of fungal diseases, aphid-transmitted plant viruses, and phytophagous insects and mites.
- **Kaligreen** by Otsuka Agritechno, EPA Reg No.70231-1. Potassium Bicarbonate soluble powder is used as a curative contact fungicide for the control of powdery mildew.
- **Topsin M WSB,** by United Phosphorus, EPA Reg 73545-16-70506. Thiophanate-Methyl Fungicide for the control of Botrytis and Eutypa**.**

At times we add the following surfactants (except with Kaligreen and Stylet-Oil):

- **No Foam B** by Creative Marketing Research, CA Reg No. 1070775-50008-AA. Surfactant blend to act as spreader-activator & buffer.
- **Vintre** by Oro Agri, CA Reg. No. 72662-50004-AA, a surfactant to improve distribution and efficacy of miticides & fungicides.

Animal Control

Wildlife is adorable, but it can interfere with agriculture. We are concerned with the following vertebrate pests:

- **Deer** eat the foliage of vines and thus kill the plants top down. They are protected in our area (i.e., illegal to shoot). Therefore the only solution is to keep them away with a 10-foot fence surrounding the property
- **Gophers** eat the roots, particularly roots of young vines, and are thus particularly harmful in new plantings – they kill the vines bottom up. They are hard to detect because they live underground in extensive burrow systems
- **Ground Squirrels** can damage vines by eating the bark of established vines, and they dig extensive burrow systems, particularly at the perimeter of vineyards. They also expand abandoned gopher holes
- **Rabbits** eat the foliage of young vines but, given their reach, are only harmful in very young plantings. Their burrows, however, can be destructive.
- **Wild Turkeys** have recently been introduced in our area to add more diversity to the wildlife. They can be very destructive due to their size; they disrupt the ground cover and damage the canopy.
- **Yellow Jackets** have become a recent nuisance. They slice open maturing berries and suck out the sweet juice.
- **Birds** eat the almost-ripe berries before they are ready to pick and thus must be kept away late in the season

There are other animals (voles, wild pigs, etc.) that can do significant harm, but they are less prevalent in our area. Of course, there is also highly beneficial wildlife, to mention bees for pollination and owls, which eat gophers.

The following paragraphs explain how we deal with each of the seven pests mentioned above. Note, certain vineyard practices mentioned earlier (like planting roses at row ends for early detection of mildew and planting cover crops for soil maintenance) attract these pests; there is a complex interplay between different practices.

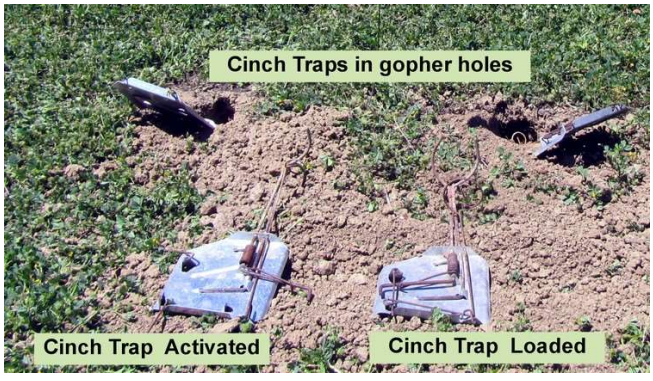
Deer

Deer presented a significant problem during the early years until we secured the property by a 10-foot fence and discouraged them from revisiting their old habitat by crashing through the fence.

Gophers

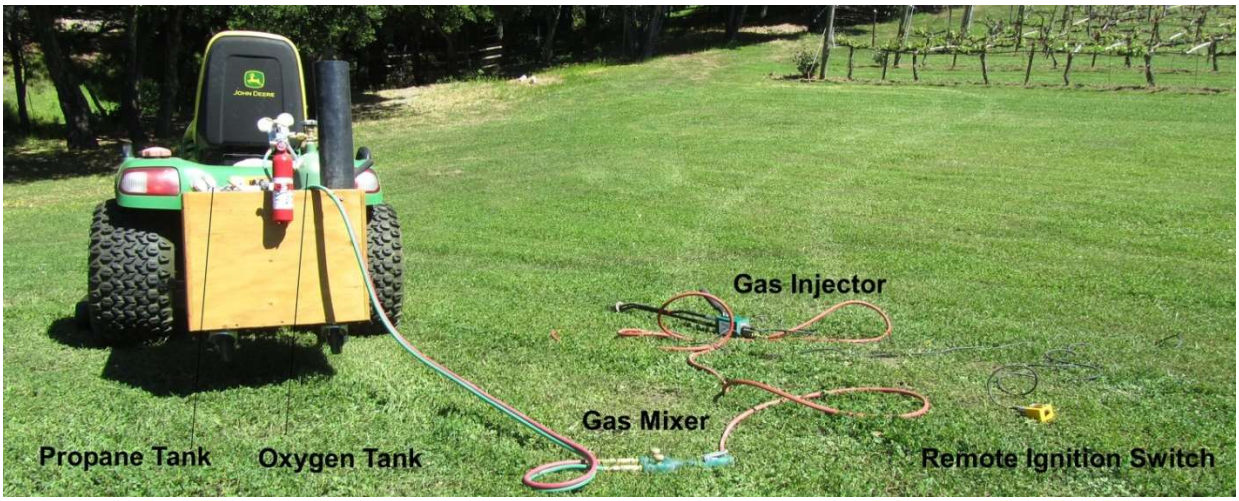
Gophers continue to be our biggest constant challenge as surrounding fields are their natural habitat, and they cannot be fenced out. They are hard to detect and harmful because they live underground and eat the roots of living plants. Early on, we lost about 15% of all vines to gophers and needed to replant with new ones. Gophers signal their location; they leave mounds at the end of the tunnels they burrow at night. We keep the ground finely tilled or evenly mowed to notice the mounds quickly. We also planted roses at the end of each vineyard row because gophers like their roots even more than vines' roots. In spring, we survey the vineyard every morning for new mounds, starting around the roses. When we find a mound, we try to kill the gophers with one of the following methods

Traps: Cinch Traps are the easiest and least time-consuming to deploy. Just set the trap and stick it into the cleared hole. Best to do this in the early morning. This website sells traps and explains how to deploy them: http://www.gopherslimited.com/index.html.



CO2 gassing: Sometimes, the Gophers get smart and dig around the cinch traps. When that happens repeatedly, we escalate to CO2 gassing. We attach a hose to the exhaust pipe of a combustion engine and feed CO2 into the tunnel for 15 minutes. The picture on the right shows the use of a small tractor for this purpose. An alternative is to use a special-purpose engine, as we explain below. The problem with this method is there is no immediately visible proof of success.

Detonation: when neither Cinch Traps nor gassing works, we escalate, as a last resort, to blowing up the gopher tunnels with a "Varmit Getter Original." The contraption mixes propane with oxygen and injects a small amount of the mixture into the gopher tunnel, and then ignites the tunnel remotely.



We catch 50-100 gophers each season. It is essential to keep the gopher population under control; otherwise, they dig extensive tunnel systems and become harder to catch before they eat the vines' roots.

Ground Squirrels

Ground squirrels live in nearby woods and have become a nuisance because they expand abandoned gopher burrow systems at the periphery of the vineyard. We used to spread lethal bait around their holes (Tomcat, PCQ Ground Squirrel Bait, made by Bell Laboratories, Madison, WI). However, these baits are problematic because the animals that eat the dead squirrels might get poisoned as well. Consequently, we have switched to CO2 gassing with a special-purpose engine made by BurrowRX: http://www.burrowrx.com/. An alternative is to catch the squirrels in above ground cages; this website sells a good cage: http://www.gopherslimited.com/index.html

Rabbits

Rabbits invade the vineyard from surrounding fields. They are less of a problem for vines than they are for rose bushes (which help detect mildew). We have not been very successful in trapping them, so we tend to fumigate their nest at the periphery of the vineyard with CO2 from the tractors or with the BorrowRX unit.

Turkeys

Turkeys have become a pest only since 2018 after the government decided to repopulate our area to enhance wildlife. They appear in spring in large flocks (often 20+) and stay through autumn before the hunting season. Because of their size and lack of familiarity with vineyards, they can be very destructive to trellises and fences – they also pick maturing grapes right through the nets. We have not yet found a legal way to get rid of them.

Yellow Jackets

Wasps, and particularly Yellow Jackets, have become an increasing nuisance. They are attracted by the high sugar content during the final maturation period and slice the grape skins.

While bees help in the pollination, Yellow Jackets don't, and they provide no benefits in the vineyard. The best way to keep them away is to use tightly-woven nets.

Birds

Birds represent a significant challenge shortly before harvest – they devour grapes after Veraison when their sugar content rises. We are located in an area with a wide range of trees and bushes attracting many birds of all kinds. The following section on Netting explains how we prevent them from eating the fruit.

Netting

Birds will start eating grapes as soon as they turn color at Veraison. You can either scare the birds away or shield the grapes with netting. We first tried to scare them away but were not very successful, so we resorted to nets.

The most effective way to prevent the birds from eating the crop is to put a net over all the vines. However, nets significantly complicate grape thinning and testing after Veraison. We can delay netting until grape thinning is completed and keep the birds away temporarily. We can accomplish this by installing a device producing bird distress calls – effectively fooling the birds into believing that their brethren in the vineyard are in distress and it's better to stay away. We use a BirdBard Pro Plus Combo purchased from JWB Marketing (see suppliers). It's a unit that generates distress calls of selected bird species electronically and disperses the sound over two loudspeakers on top of a high pole. The device is powered by a car battery which in turn is trickle-fed by a solar panel. We initially thought this would be enough of a bird deterrent eliminating the need for netting. Unfortunately, the birds learn that they are being fooled, and when the vineyard is in an area with a dense bird population – like where we are – their learning curve is fast, and the fake distress calls cease to be effective after a few weeks. This is still long enough to wait with netting until the Veraison is complete.

We used woven nylon netting Bare-Hand Flex Bird Nets from Plantra, Inc (651) 686-6688, which is 17 feet wide and comes in 1250 foot rolls. The nets are cut to the lengths of the vineyard rows and stored during the year in plastic containers.

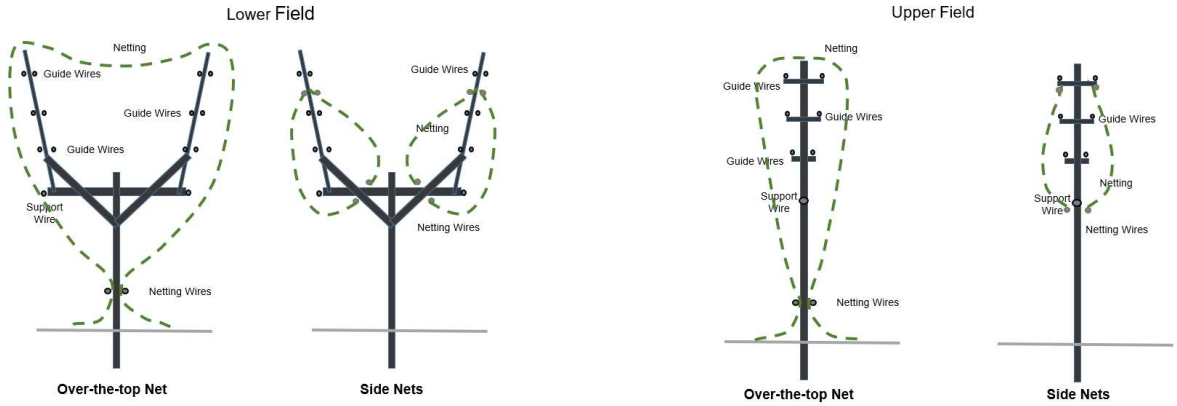
Right after grape thinning, we draped the nets over the top of the dual canopies with a netting applicator attached to the back of a tractor. Then the nets are closed under the vines with two detachable wires hooked to the trellising trunks and held together with hog clips. The nets are kept away from the top of the trellising structures by metal tubes in the form of walking sticks.

Right before picking, we used to flip the nets on each side over the top of the canopy to provide access to the grapes. After harvest, the nets are removed by reversing the application process – i.e., by pulling the nets off the canopy with the help of the netting applicator. Net application and net removal, in the lower field alone, used to take around 5 hours each for three people: one person driving the tractor, one person in the netting applicator, and one person on the opposite side of the row.

In 2016 we started replacing the seasonal draped-over-the-top nets described above with permanently installed side-nets (Permanets from SpecTrellising https://www.spectrellising.com/). These nets are more expensive and tedious to install at the outset, particularly on quadrilateral cordons. But they have significant advantages:

- They take only minutes to put up or take down (vs. hours with traditional nets)
- They should last longer (10 years vs. 3-5 years)
- They have a finer mesh which not only keeps birds out but also wasps
- They can easily be removed temporarily to take grape samples in the final weeks of maturation.

The following graphic illustrates the switch from Over-the-top Nets to Side Nets.



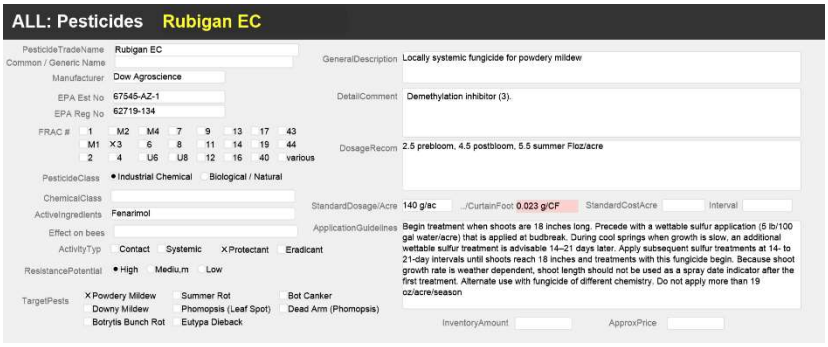
Time will tell how long they last and whether they are worth the installation effort.

Data Management

Data management for pest control involves the following tables and layouts:

- “ALL: Pesticides”-layout holds the descriptions of the pesticides currently in use and inventory
- “ALL: Adjuvants”-layout holds the descriptions of the surfactants currently in use and inventory
- “ALL: SprayProgramEntry”-layout holds the contemplated entries for pesticide, adjuvant and foliar sprays planned for the upcoming growing season
- “REVIEW: SprayProgram”-layout shows the summary of all SprayProgramEntry records for the upper and lower fields in a season
- “INPUT: VineyardActions”-layout is used to enter pest management activities

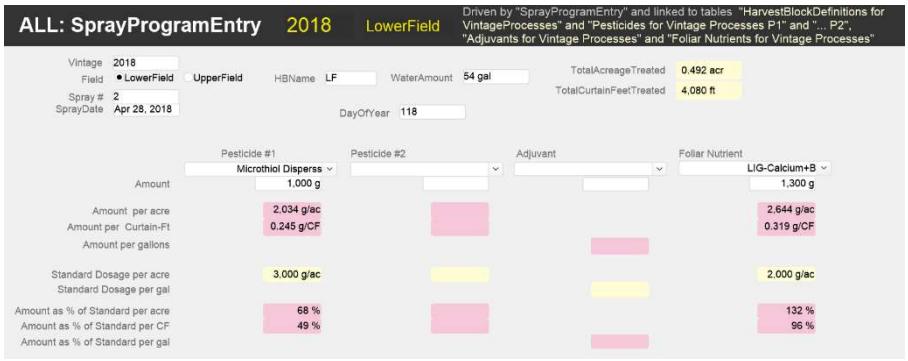
The screenshot on the right shows the “ALL: Pesticides”-Layout for the pesticide Rubigan EC. The table holds information generally found on the product label. We convert the standard dosage, usually given in lbs/acre, into g/curtain foot, assuming a typical vineyard has 6000 feet of



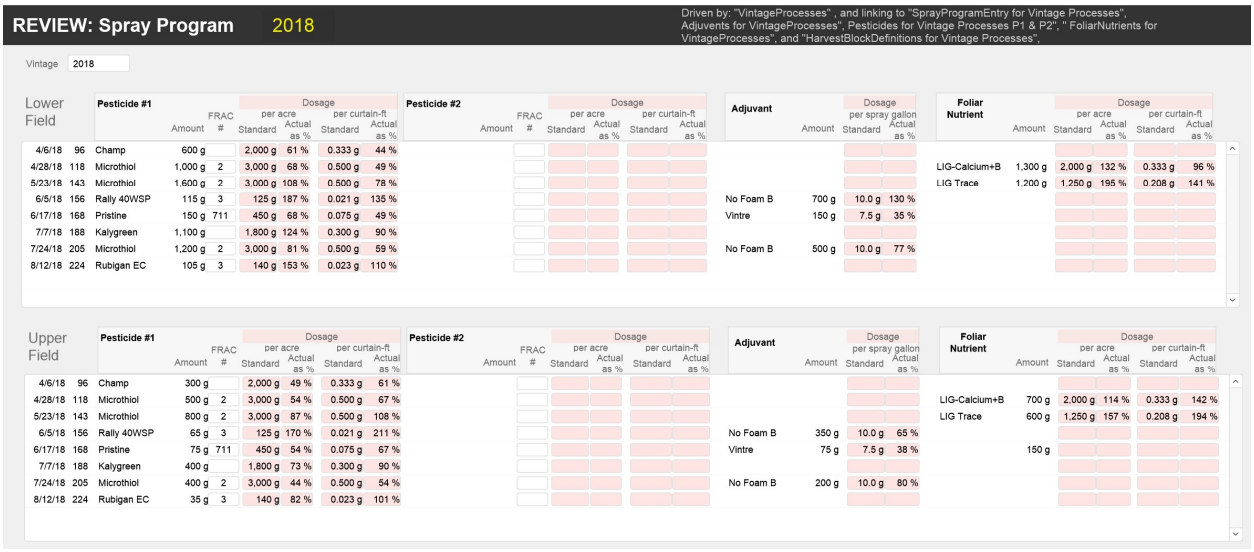
canopy per acre. Our lower vineyard with the quadrilateral trellis has 8,300 feet of curtain, or canopy, per acre. Our upper vineyard with the bilateral trellis has 4,800 feet of curtain per acre. In our view, curtain feet are a better measure for the amount of vegetation to be protected than acreage. Further note that the table also contains the critical FRAC numbers and directions for spray applications.

The following screenshot shows the “ALL: Adjuvants”-Layout for Vintre, a surfactant used in combination with pesticides and nutrient sprays. Surfactants improve the effectiveness of sprays by breaking down the surface tension in the spray droplets and thus improving the contact and adherence to the leaves. The dosage is given in grams per gallon of spray volume.

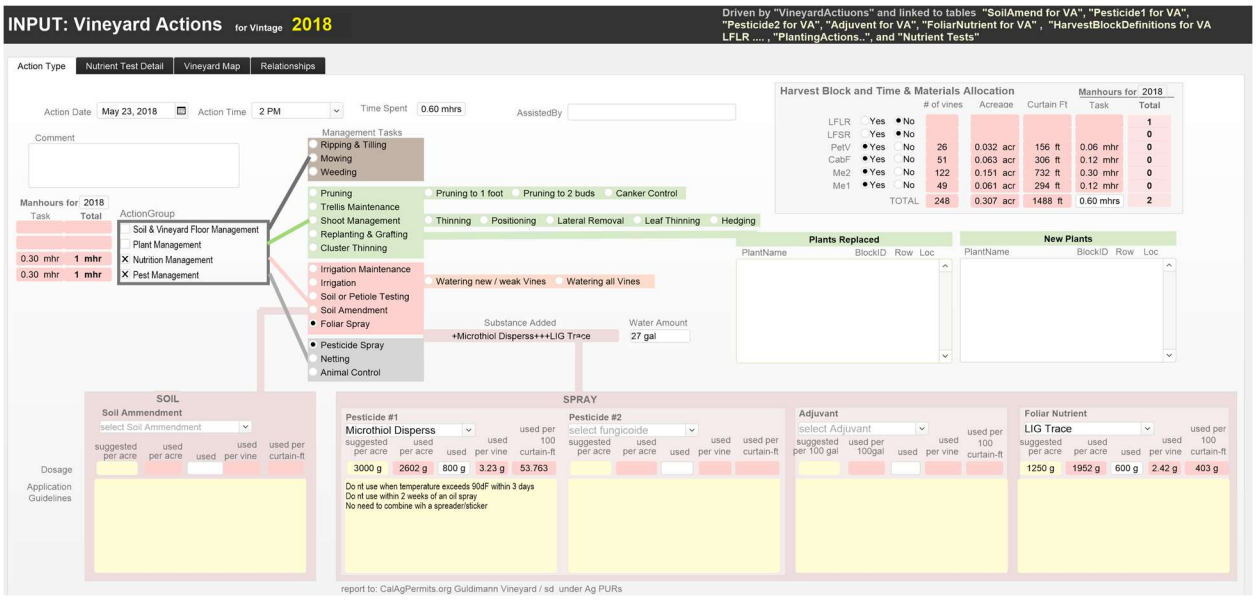
At the beginning of each season, we set up a spray plan. It specifies when which pesticide, adjuvant and foliar spray will likely be used and in what amount. Entries to this spray program are made in the “ALL: SprayProgramEntry” layout, which has a record for each spray action in the lower and upper fields. This screenshot shows the record for spraying a combination of Microthiol and LIG-Calcium in the upper field on April 28, 2018.



The following screenshot of the layout “REVIEW: Spray Program” shows how we combined pesticide, surfactants, and foliar sprays in 2018. Each line in the tables represents one Spray Program Entry.



All Pest Management actions are recorded in the “INPUT: VineyardActions”-Layout. The following screenshot shows the Microthiol + LIG-Trace application on May 23, 2018. We sprayed 800 g of Microthiol and 600g of LIG-Trace with 27 gallons of purified water in the upper field.



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Last updated: May 7, 2021

Weather Monitoring

We monitor key weather variables (temperature, humidity, rainfall) in the vineyard for four purposes:

1. To estimate the anticipated picking date to plan and schedule the crew. We do this by tracking temperature in hourly intervals and calculating / graphing Growing Degree Days
2. To estimate the vulnerability of the vines to diseases, particularly mildew, to schedule spraying with fungicides. We do this by tracking a Mildew Pressure Indicator derived from temperature and humidity.
3. To evaluate the need for irrigation.
4. To provide an annual narrative for the weather to characterize the vintage.

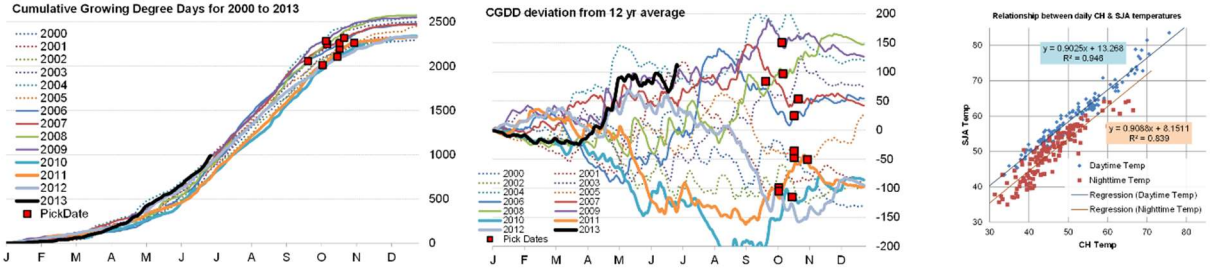
We started collecting weather data consistently only in late 2012. For this, we use a Vantage Pro2 weather station from Davis (http://www.davisnet.com/weather/products/weather_product.asp?pnum=06152) to collect rain, temperature, and humidity data.

Growing Degree Days

Growing Degree Days (GDD) measures the heat plants have been exposed to over a season. The assumption is that grapes develop commensurate with the temperature multiplied by the time they are exposed to that temperature. The temperature needs to be above 55°F to start counting and not higher than 95°F. In simple terms, 1 GDD is accumulated when a plant is exposed to 58 °F for 8 hours (i.e., 58-55) * 1/3rd day). To calculate GDDs with reasonable accuracy, we need long histories of consistent hourly temperature readings and compute the sum of Growing Degree Hours divided by 24. Reliable data is available free at the National Oceanic & Atmospheric Administration (NOAA) 's website http://www.nc°C.noaa.gov/. For temperature data, go to http://gis.nc°C.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=temp&layers=1, select a location and download the data for the required time period.

Why then do we need our own weather station?

Long, high-quality time series of climate data is generally collected at airports only. We downloaded hourly data for the nearest airport (San Jose Airport, SJA) for 12 years and then computed the Cumulative GDDs. The graph on the left shows the result. The little red squares indicate the dates each year when we picked the grapes in the lower field. Note, at San Jose Airport, approx. 15 miles away, CGDDs reach somewhere between 2000 and 2400 by the time we pick at Chateau Hetsakais. If the San Jose Airport CGDDs measured ripeness accurately, all red squares should lie on a horizontal line theoretically. To look at this more closely, we computed the difference of each year's CGDD curve with the average of all 12 years. The middle graph shows the result.



Again, the red squares should lie on a steeply sloping line because we would expect to have picked earlier in relatively warmer years and later in relatively cooler years. But it does not look like we did. There could be three different reasons for this "disconnect": Either the GDD theory is not valid (I doubt it), or we did not pick at the same level of ripeness each year (possible), or the weather is different at S.J. Airport when compared to our vineyard (probable).

To test the latter, we checked the correlation of average daily daytime and nighttime temperatures between San Jose Airport and temperatures collected at our vineyard (only available for 2013. This graph on the right shows the result. The relationship is not very tight, with linear regressions showing R-Squares of less than 0.95. My conclusion is that we cannot rely on historical data collected at San Jose Airport. Instead, we need to collect our own data history. This is why we need our own weather station.

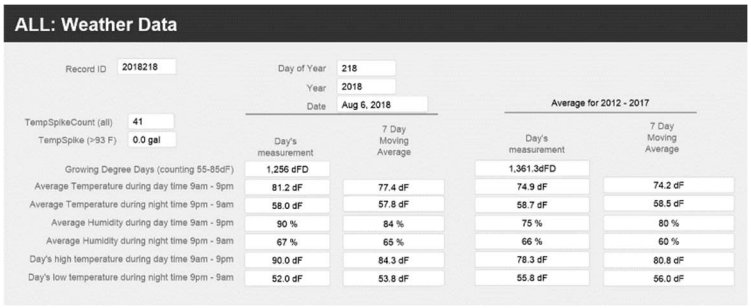
Data Management

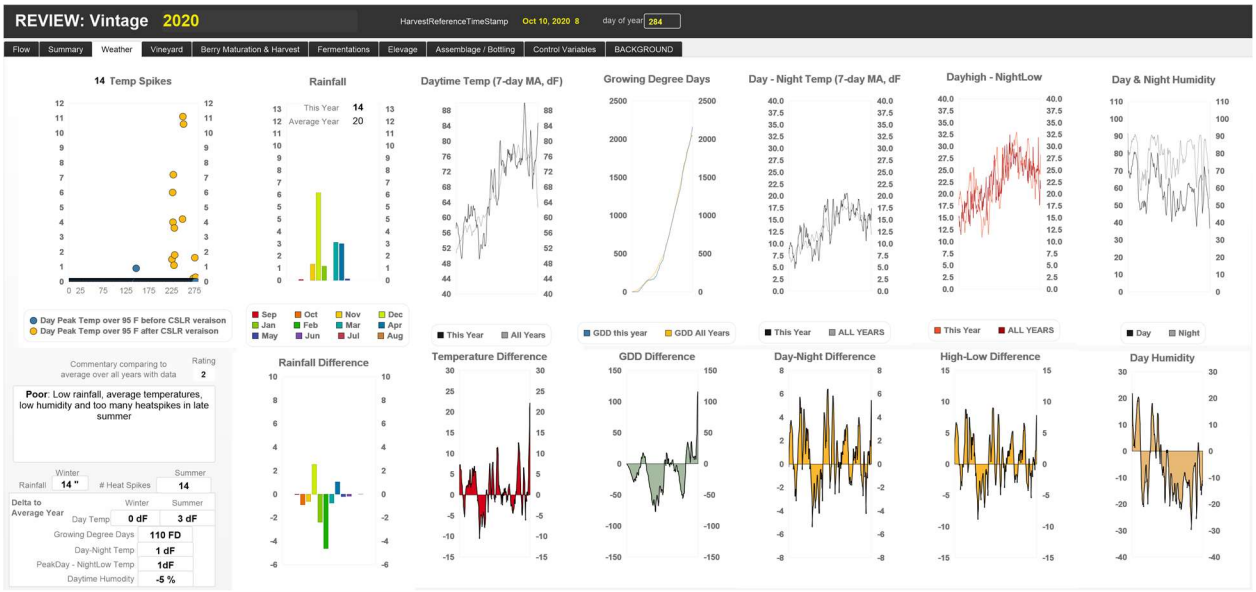
We purchased a Vantage Pro2 weather station from Davis and collected our hourly weather data since mid-2012.

At this juncture, we only track and analyze the hourly temperature and humidity data. In the future, we plan to collect and analyze a broader range of data, including humidity, rainfall, U.V. intensity, etc. From the hourly data, we compute for every vintage in a spreadsheet:

- Average temperature between 9am & 9 pm (day-time)
- Average temperature between 9pm & 9am (night-time)
- Average humidity between 9am & 9 pm (day-time)
- Average humidity between 9pm & 9am (night-time)
- Highest and Lowest temperatures for the day
- Cumulative Growing Degree Days with 55dF and 95dF cutoff points
- Average data for 2012 through the current year for every day of the year
- 7-day moving averages of all the above

Then we enter this data from the spreadsheet into the “WeatherData” table of the database. On the right is a screenshot of the day’s data for August 6, 2018. The following screenshot of the “Weather”-tab in the “REVIEW: Vintage”-Layout illustrates in the Weather tab how we use the weather data to summarize weather conditions for the 2020 vintage.





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