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Institute for Food and Agriculture

The Production Economics of Managing Color In Hot Climates Using Mechanization and Irrigation - A Case Study

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Objective

- This study aims to construct an economic analysis of merlot production in San Joaquin Valley (SJV).
- Four different scenarios are constructed for merlot production with various leaf removal and irrigation treatments in an experiment by the Viticulture and Enology Research Center (VERC) at California State University, Fresno.

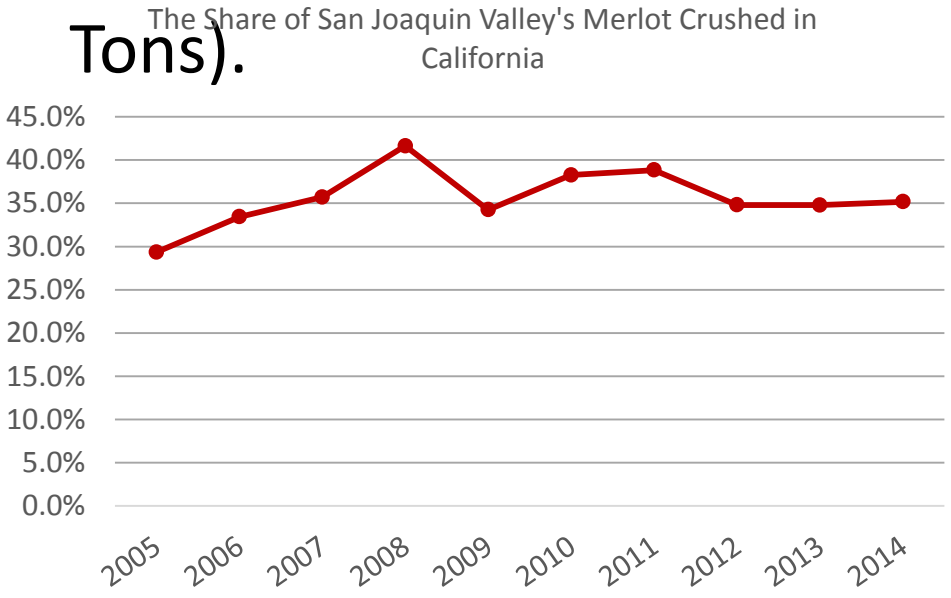
MOTIVATION

- These treatments improves grape color compound (anthocyanin) both quantitatively and qualitatively.
- Related with weather conditions, treatments increase cost and sometimes cause significant yield decrease compared to the base production scenario.
- Thus, we provide information for a new price level (premium price) for each scenario so that the growers can improve the color by these treatments and might be able to compensate the negative weather impact.

Merlot for Wine Production in California

In 2014,

- 2.8 MT merlot crushed in California (13% of red wine grapes crushed),
  - 35% of merlot grapes are crushed in SJV (993 thousand Tons).



Source: California Grape Crush Reports (USDA, 2005-2014)

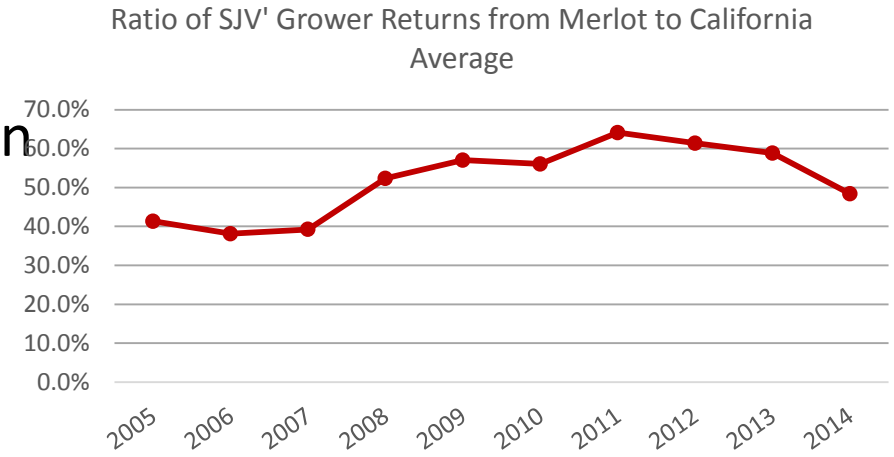
Source: Madera/Fresno County
http://winegrapesdirect.com/?page_id=101

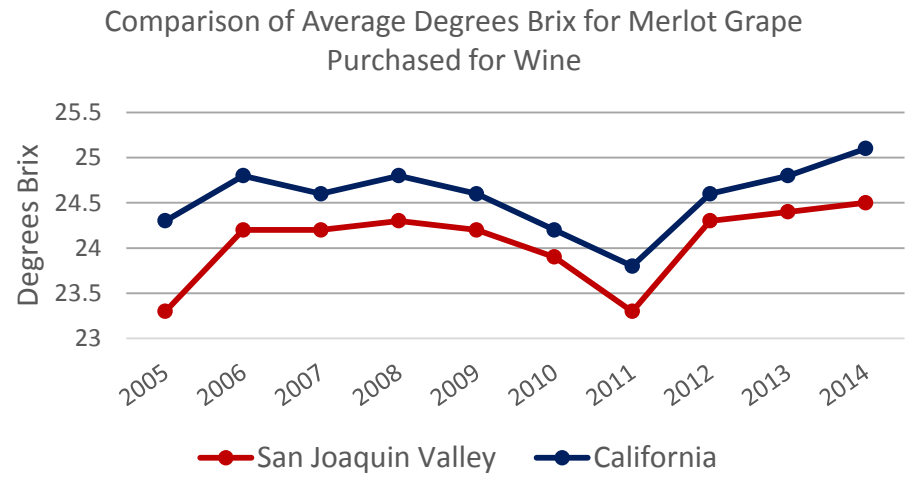
Merlot Grower Returns in San Joaquin Valley vs. California

In 2014,

- Average grower returns per ton for merlot is $774.7/ton in California while it is only $374.8/ton in SJV.

Source: http://www.winesandvines.com/





Source: California Grape Crush Reports (USDA, 2005-2014)

Grape COLOR and Prices

- Studies find a strong positive correlation between wine grape color (anthocyanin concentration) and price (Webb 2006).

- SJV is known with Low Anthocyanin accumulation.

Source: Wine color app on iPad

Experimental design - Case Study*

- Place: San Joaquin Valley of California
- Crop: Wine grape, Merlot
- Seasons: 2013 – 2014 (drought)
- Treatments:
  - Mechanical leaf removal
    - Control – no leaf removal
    - Leaf removal at Pre-bloom stage
    - Leaf removal at Post-fruit set
  - Irrigation treatment
    - Sustained deficit irrigation (SDI)
    - Regulated deficit irrigation (RDI)
- Grapes are harvested at 24° Brix

Source: http://www.fresnostatenews.com/

* Please visit Kurtural et al. (2015) for more information about the experiment.

Kurtural et al. (2015) Anthocyanin Composition of Merlot Grapevine is Ameliorated by Light Microclimate and Irrigation in Central California, American Journal of Enology and Viticulture, 66(3): forthcoming.

Differences in SDI and RDI

- Sustained deficit irrigation (SDI):
  - 0.8 ETc and -1.2 MPa from anthesis to harvest

- Regulated deficit irrigation (RDI):
  - 0.8 ETc and -1.2 MPa from anthesis to fruit set
  - 0.5 ETc and -1.4 MPa from fruit set to veraison
  - 0.8 ETc and -1.2 MPa from veraison to harvest

Significant Experiment Results - Yield

- Leaf removal
  - The pre-bloom and post-fruit set leaf removal treatments reduced the berry skin mass by 6% and 18% in 2013 and 5% and 13% in 2014.
  - The berry mass and the cluster mass were reduced by approximately 7% and 13% by both pre-bloom and post-fruit set in 2013, respectively.
- Irrigation Regime
  - RDI reduced the berry mass by 6% and 9% in 2013 and 2014, respectively, compared to SDI.
  - In 2014, RDI reduced the cluster mass and yield by approximately 13%, compared to SDI.

Significant Experiment Results – Berry and anthocyanin composition

- Brix:
  - Post-fruit set leaf removal decreased Brix by 3% when compared to both control and pre-bloom leaf removal in 2013.
  - RDI increased Brix by 2% and 2.5% in both 2013 and 2014, respectively, compared to SDI.
- Color:
  - Anthocyanin analysis was conducted with the HPLC system.
  - In both years of the study the pre-bloom leaf removal treatment increased total skin anthocyanin (TSA) amount by 25% compared to control. The irrigation treatments did not affect TSA amount in either year.
  - Qualitative anthocyanin: Leaf removal did not affect them in either year. The SDI treatment increased them in both years when compared to RDI.
  - RDI develops stable color.

* Please visit Kurtural et al. (2015) for more information about the results.

Observations Summary

Effects of mechanical leaf removal and fractions of crop evapotranspiration application on components of yield and yield efficiency of 'Merlot 01/Freedom' in northern San Joaquin Valley of California (n = 4).							
	Berry mass(g)	Berry skin mass(mg)	Cluster mass(g)	Yield (kg/m)	TSS (%)	Juice pH	TA (g/L)
Leaf Removal				**2013**			
Control	1.36	55	167.7	6.64	24.6	3.57	5.26
Pre-bloom	1.27	51.7	147.4	6.34	24.7	3.59	4.78
Post-fruit set	1.28	45	143.5	6.78	24	3.58	5.06
Pr>F	0.0216	0.002	0.0029	0.4996	0.0171	0.6783	0.0779
ETc fraction							
SDI	1.34	51.3	153.5	6.86	24.2	3.59	5.04
RDI	1.26	47.8	152.2	6.31	24.7	3.57	5.02
Pr>F	0.0068	0.5103	0.8379	0.0748	0.0206	0.2531	0.8853
LR x ETc fraction	0.9004	0.9074	0.5665	0.8684	0.8882	0.7035	0.7264
Leaf Removal				**2014**			
Control	1.09	45.3	111.7	6.17	24.3	3.6	4.83
Pre-bloom	1.07	42.9	109.9	6.1	24.1	3.62	4.66
Post-fruit set	1.11	39.5	106.8	4.46*	24.2	3.64	4.69
Pr>F	0.5314	0.031	0.6426	0.0016	0.7905	0.211	0.4152
ETc fraction							
SDI	1.14	42.7	116.4	6.08	23.9	3.63	4.83
RDI	1.04	42.3	102.3	5.27*	24.5	3.61	4.62
Pr>F	0.0021	0.6963	0.0001	0.0003	0.0199	0.288	0.0786
LR x ETc fraction	0.4878	0.5892	0.9943	0.0053	0.6608	0.5241	0.9698

*** Significant difference in yield.**

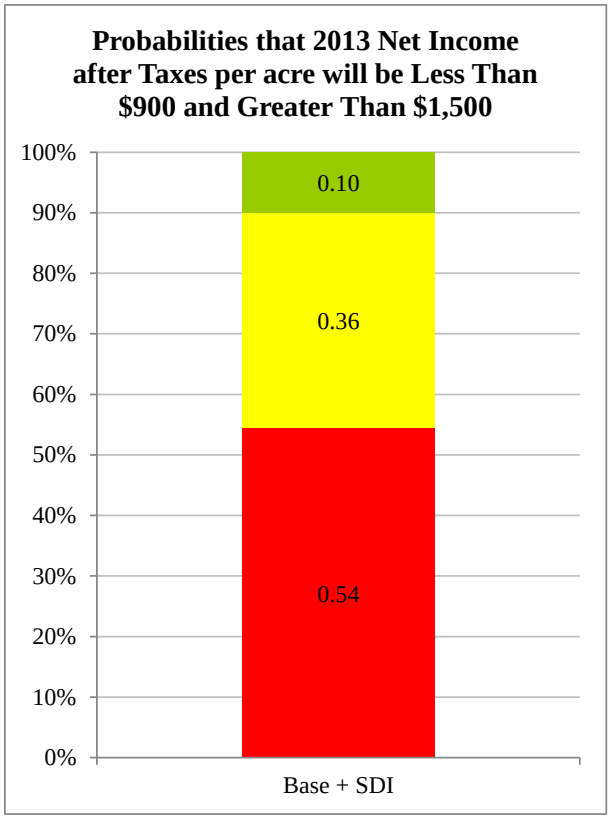
Cost Items Associated with Treatments

	Pruning cost	Leaf removal cost	Irrigation applied	Irrigation water cost
	($/ha)	($/ha)	(ML/ha)	($/ha)
		2013		
Control+SDI	748	0	2.37	950
Pre-bloom+SDI	748	30	2.37	950
Pre-bloom+RDI	748	30	2.03	827
Post-fruit set+SDI	748	30	2.37	950
Post-fruit set+RDI	748	30	2.03	827
		2014		
Control+SDI	748	0	3.08	1,235
Pre-bloom+SDI	748	30	3.08	1,235
Pre-bloom+RDI	748	30	2.6	1,029
Post-fruit set+SDI	748	30	3.08	1,235
Post-fruit set+RDI	748	30	2.6	1,029

* Effects of mechanical leaf removal and fractions of crop evapotranspiration application on labor operations cost of canopy management in northern San Joaquin Valley of California (n = 4).

Baseline & Experiment Results 2013

- Control and SDI is taken as a base for merlot production in the valley.

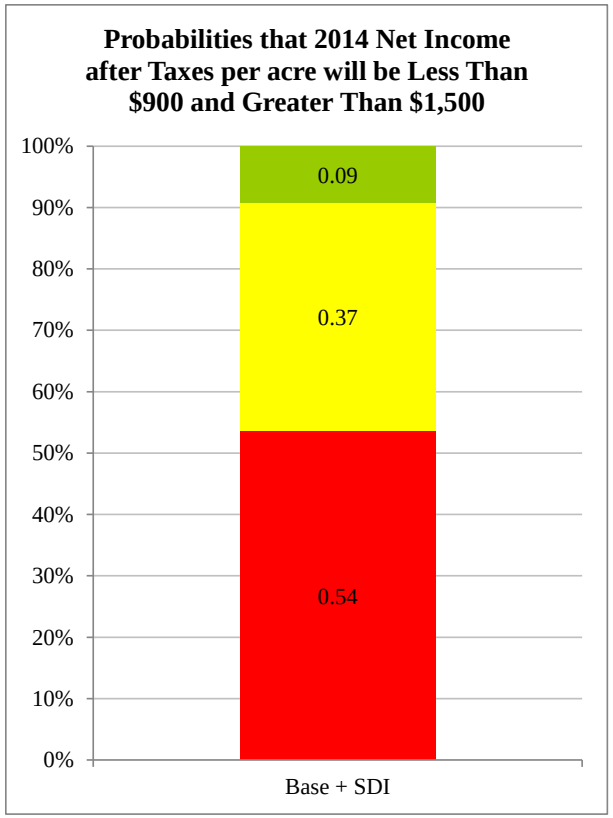


- Irrigation Cost (SDI): $950/ha ($385/acre)
- Yield: 11.4 ton/acre
- Price: $443/ton

- No significant yield change in 2013.
- No need to increase price significantly to compensate the cost, yet experiments results show improvements in color components.

Results – 2014 (1/5)

- We observe the impact of drought severely in 2014 yield result.



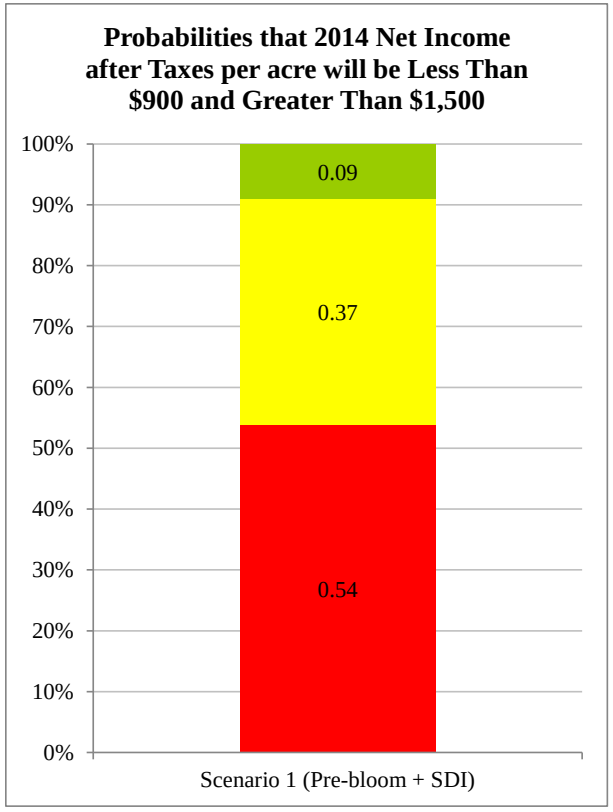
- Irrigation Cost (SDI): $1235/ha ($500/acre)
- Yield: 10.0 ton/acre
- Price: $514.5/ton*

- Yield decrease significantly in 2014 with post-fruit set leaf removal and RDI treatment.
- We will need to increase price to compensate the cost.

* Note: Developed from referenced price of cabernet sauvignon in SVJ by using percentage difference in prices between cabernet sauvignon and merlot from the pricing district 13, Grape Crush Report Final 2014 (March 10, 2015).

Results – 2014 (2/5)

- Scenario 1: Pre-bloom + SDI

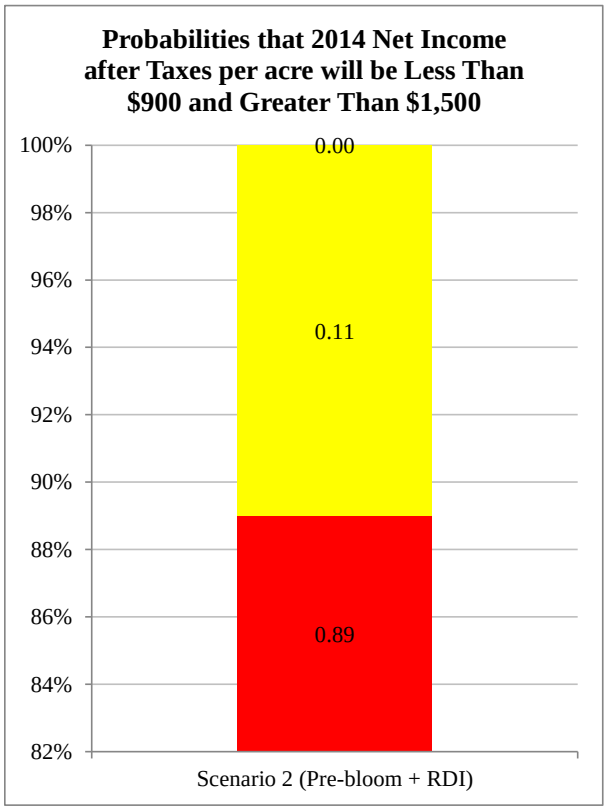


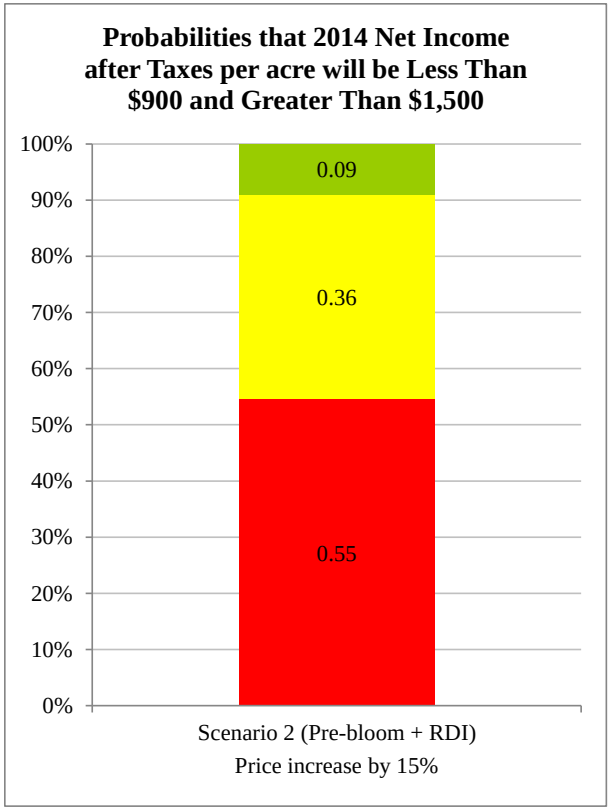
- Irrigation Cost (SDI): $1235/ha ($500/acre)
- Yield: 10.0 ton/acre
- Cost increase: $30 extra cost for leaf removal.

- New Price Level: $514.5/ton
- TSA: Increase TSA by 25% and high in valuable anthocyanin.

Results – 2014 (3/5)

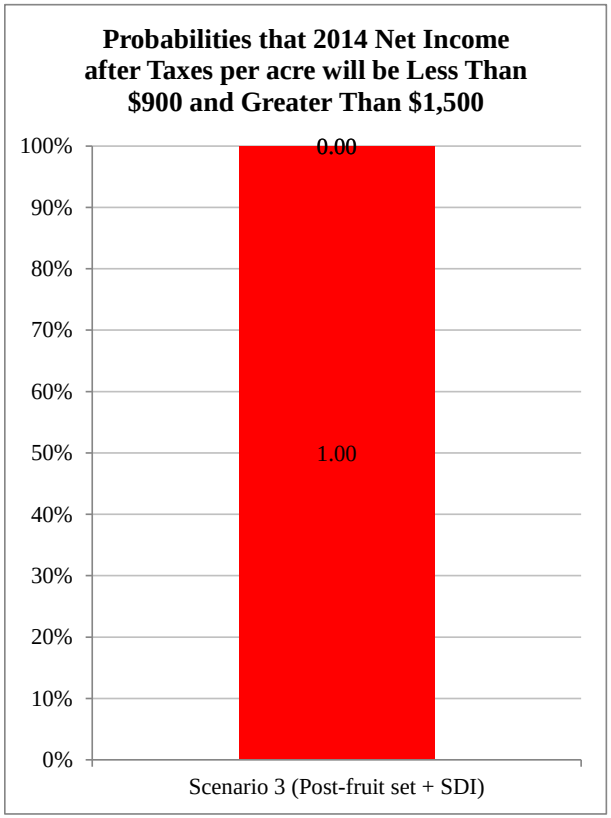
- Scenario 2: Pre-bloom + RDI

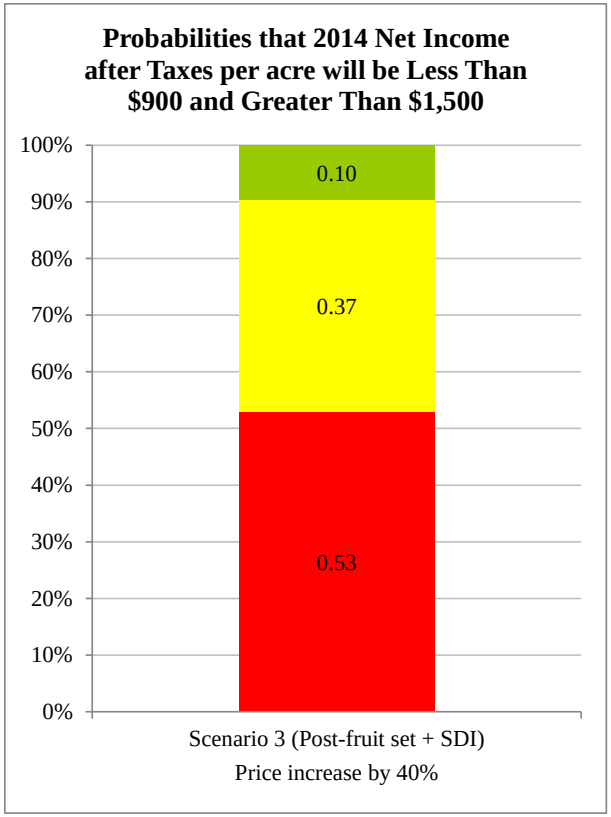




Results – 2014 (4/5)

- Scenario 3: Post-fruit set + SDI



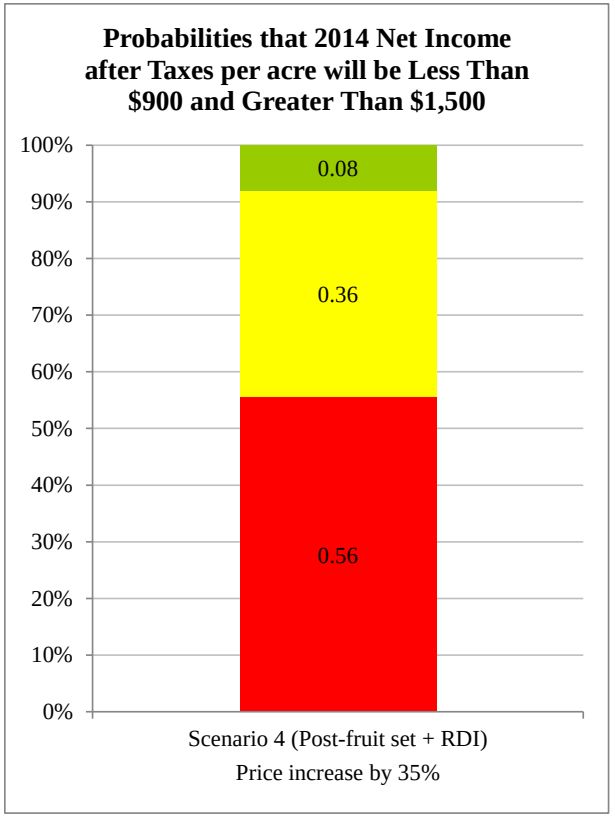


Irrigation Cost (SDI): $1235/ha ($500/acre);
Yield: 7.2 ton/acre
Cost increase: $30 extra cost for leaf removal

New Price Level: $720/ton
TSA: High in valuable anthocyanin.

Results – 2014 (5/5)

- Scenario 4: Post-fruit set + RDI



- Irrigation Cost (RDI): $1029/ha ($416/acre)
- Yield: 7.2 ton/acre
- Cost increase: $30 extra cost for leaf removal

- New Price Level: $695/ton
- TSA: insignificant increase in amount. More stable color and retain it.

Conclusion

- Leaf removal and deficit irrigation treatments improves the anthocyanin (color compounds) level of merlot grape.
- However, these treatments have significantly negative impact on yield and grape's mass content when the severity of drought is high.

- The treatments will increase the negotiation power of growers and also improves the wine quality.
- The new price levels should be studied well. Since, they only compensate the grower's cost while it would open high value markets for wine processors.

Thank You!

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RESULTS Summary

Experiment					
2013					
					Base Price = 443 ($/ton)
		Experimental Cost		Yield	Need to increase Price, at least, by
		$/ha	$/acre	ton/acre	$/ton
Control + SDI		950	384.45	11.4	
Control + RDI		827	334.68	11.4	
Pre-bloom + SDI	S 1	980	396.56	11.4	
Pre-bloom + RDI	S 2	857	346.82	11.4	No Changes
Post-fruit set + SDI	S 3	=S1		11.4	
Post-fruit set + RDI	S 4	=S 2		11.4	
2014					
					Base Price = 514.5 ($/ton)*
		Experimental Cost		Yield	Need to increase Price, at least, by
		$/ha	$/acre	ton/acre	$/ton
Control + SDI		1235	499.79	10	
Control + RDI		1029	416.42	10	
Pre-bloom + SDI	S 1	1265	511.93	10	No Change
Pre-bloom + RDI	S 2	1059	428.56	8.5	15% to 591.68
Post-fruit set + SDI	S 3	=S1		7.2	40% to 720.30
Post-fruit set + RDI	S 4	=S 2		7.2	35% to 694.58

*** Note: Developed from referenced price of cabernet sauvignon in SVJ by using percentage difference in prices between cabernet sauvignon and merlot from the pricing district 13, Grape Crush Report Final 2014 (March 10, 2015).**

Additional Figures