Manipulating Soil Moisture and Nitrogen Availability to Improve Fermentation Behavior and Wine Quality

Part III: Effects on Wine Color, Aroma and Flavor

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Introduction:

1999 Pinot noir wines from the Oregon State University viticulture trials at Benton Lane vineyard were evaluated using free-choice profiling by a panel of 16 Oregon winemakers in January 2001. This work is the continuation of the project described in *Manipulating Soil Moisture and Nitrogen Availability to Improve Fermentation Behavior and Wine Quality* from the March 2000 OSU Winegrape Research Day Presentations.

Materials and Methods:

Three field replications of the twelve field treatments (Table 1) were harvested from the experimental plots at Benton Lane vineyard. Thus, thirty-six total lots of wine were made following the protocol laid out by Watson et al, 2000.

Table 1: Viticultural Treatments

	Irrigated		**Dry (Not Irrigated)**	
	Tillage	**No Tillage**	**Tillage**	**No Tillage**
Zero Nitrogen	I T 0N	I NT ON	D T 0N	D NT 0N
Foliar Nitrogen	I T FN	I NT FN	D T FN	D NT FN
Soil Nitrogen	I T SN	I NT SN	D T SN	D NT SN

Sixteen Oregon winemakers participated in a tasting of the experimental wines. A descriptive analysis technique called 'free choice profiling' was used to evaluate the wines. This technique allows panelists to develop their own descriptors in addition to the backbone of descriptors provided on the ballot. The ballot used during evaluation is included in appendix 1. Table 2 lists other descriptors generated during ballot development. The winemakers evaluated the wines for aroma and flavor during seven sessions spread over two days. No overhead lighting was used during this phase of evaluation; light was limited to less than 10 lux coming from open curtains.

The wines were evaluated for color in a separate session following the aroma/flavor evaluations. Tables were covered with white paper and wines were presented in high quality crystal glasses. Light conditions include a mixture of natural and incandescent lighting at an average of 40 lux.

Table 2: Other Descriptors Generated During Ballot Development

Cherry	Dust	Hot	Hay	Rose petal
Berry	Black fruit	Alcoholic	Stemmy	Grassy
Vanilla	Red fruit	Finish alcohol	Blackberry	Brown spice
Citrus	Exotic spices	Length on palate	Reduced	Herbaceous
Anise	Pepper			

The data were first analyzed to see if treatment differences were significant when compared with differences due to the natural variation of the vineyard. A general multivariate linear model was used to look at the differences between the error term of the full model and the error term of the three-way interaction between the three viticultural factors (irrigation, tillage and fertilization). The full factorial model including 2 and 3 way interactions was fitted. The error term from this model represents the variation caused by field differences plus noise. The error terms for the different attributes from the three way interaction (irrigation x tillage x fertilization) show that many of the attributes vary significantly across the three treatments beyond the variation inherent in the field and background noise.

Results & Discussion:

The data are presented as tables of means across the 12 treatment combinations. Samples that differ significantly across a given attribute bear different superscripts. The data are also presented as means grouped across the major treatment variables: irrigation, tillage and fertilization. Care must be taken not to read too much into these values because significant two and three way interactions exist for many of the attributes.

Table 3 shows that the treatments differed significantly for the aroma attributes *fruity, spiciness* and *earthy/musty*. For these attributes, the I T SN treatment had the lowest ratings for *fruitiness* and *spiciness* and the highest value for *earthy/musty* aroma. One of the three field replications of this treatment was reported to be "corked" at pouring. It was re-poured twice; however, it was still determined to have a distinctly earthy musty character. The reduced perception of fruitiness and increased earthy musty notes may be due to the presence of sulfide compounds; sulfide profile analysis of the wines is pending.

Table 4 shows that some of the treatments differ significantly for the attributes *fruity flavor* and *acidity* across the flavor attribute means. The I T SN treatment received the lowest rating for *fruity flavor*. The D NT 0N wine received the highest rating for *acidity*.

Tables 5 and 6 show trends involving irrigated vs. dry treatments. The dry treatments tend to be higher in the attributes *overall aroma intensity, fruity, floral* and *spicy* aromas while being lower in *vegetative* and *earthy/musty* character. Similar trends were noted with flavor attributes, with *fruity, floral*, and *spicy* ratings being higher for dry treatments. It is interesting to note that Howe et al (2000) found that berry weight was significantly lower for dry vs. irrigated treatments.

The color data presented in Table 7 show that the D T SN treatment produced the wine that was perceived to be the highest in color intensity overall. This is in agreement with the analysis of the wines which found the anthocyanin content in the new wine to be significantly ($p < .05$) higher for dry vs irrigated wines (358 mg/L vs 327mg/L) Howe (2000). A comprehensive investigation of the color differences among these wines may be found in Helms (2000).

Analysis of these wines will continue and results will be presented in the Master's thesis of Heather Hjorth.

References:

Helms, K. 2000. The Effects of Nitrogen, Tillage and Irrigation on the Color of Willamette Valley Pinot Noir Wine. Undergraduate Honors Thesis, May 2000. Oregon State University.

Howe, Jessica and M.C. Vasconcelos. 2000. Manipulating Soil Moisture and Nitrogen Availability to Improve Fermentation Behavior and Wine Quality, Part 1: Effect of Nitrogen, Irrigation and Soil Management on Vegetative Growth, Gas Exchange, Yield, and Fruit Composition. In OSU Winegrape Research Wine Advisory Board Progress Report, Oregon State University, Oregon.

Watson, Barney, Mina McDaniel, Anna Specht, Kate Wall, Chen, Hsiao-Ping. 2000. Manipulating Soil Moisture and Nitrogen Availability to Improve Fermentation Behavior and Wine Quality, Part 2: Effect of Nitrogen, Irrigation, and Soil Management on Yeast Asssimilable Nitrogen, Juice Composition at Harvest, Fermentation Behavior, and Wine Composition and Quality. In OSU Winegrape Research Wine Advisory Board Progress Report, Oregon State University, Oregon.

Watson, Barney, Kate Wall, Anna Specht, Hsiao-Ping Chen and Mina McDaniel. 2001 Manipulating Soil Moisture and Nitrogen Availability. Part II: Fermentable Nitrogen Content and Must and Wine Composition. In OSU Winegrape Research Wine Advisory Board Progress Report, Oregon State University, Oregon.

Table 3: Aroma Attribute Means by Treatment

Treatment	Treatment	AROMA OI	FRUITY	FLORAL	Spiciness	Vegetative	Earthy/Musty
D NT 0N	1	9.05	7.00^{ab}	4.84	5.45^{b}	3.73	4.17^{a}
D T 0N	4	8.33	6.69^{b}	4.27	4.81^{ab}	3.83	4.00^{a}
D NT FN	2	9.36	6.97^{ab}	4.73	4.98^{ab}	4.11	4.27^{a}
D T FN	5	8.71	6.92^{b}	4.65	4.92^{ab}	3.81	4.46^{ab}
D NT SN	3	8.58	7.02^{b}	4.67	4.81^{ab}	3.42	4.19^{a}
D T SN	6	8.80	6.97^{b}	4.47	4.59^{ab}	3.48	3.88^{a}
I NT 0N	7	8.52	7.04^{ab}	4.71	4.54^{ab}	3.44	4.02^{a}
I T 0N	10	8.73	6.77^{b}	4.60	5.23^{b}	4.27	4.23^{a}
I T FN	11	8.55	7.05^{ab}	4.63	4.86^{ab}	3.55	3.84^{a}
I NT FN	8	8.28	6.41^{ab}	4.47	5.09^{ab}	3.56	4.13^{a}
I NT SN	9	8.81	6.79^{ab}	4.08	4.92^{ab}	4.15	4.44^{ab}
I T SN	12	8.98	5.66^{a}	3.89	4.16^{a}	4.20	5.81^{b}

Table 4: Flavor Attribute Means by Treatment

Treatment	Treatment	FLAVOR OI	Fruity fl	Floral fl	SPICY FL	VEG FL	ACIDITY	Bitterness	Astringency	BODY
D NT 0N	1	9.16	7.30^{b}	3.80	5.75	4.06	7.06^{c}	4.41	5.80	6.92
D T 0N	4	8.77	7.40^{b}	3.77	5.15	3.69	6.08^{ab}	3.77	5.15	6.46
D NT FN	2	9.16	7.09^{ab}	3.81	4.84	3.72	5.94^{a}	4.27	5.44	6.70
D T FN	5	8.92	6.96^{ab}	3.75	5.42	3.96	6.54^{abc}	4.19	5.56	6.85
D NT SN	3	8.79	7.10^{ab}	3.44	5.00	3.77	6.25^{ab}	3.85	5.56	6.40
D T SN	6	8.81	7.27^{b}	3.39	5.33	3.27	6.20^{ab}	4.06	5.83	6.92
I NT 0N	7	8.73	7.13^{ab}	3.69	4.83	3.38	6.35^{abc}	4.13	5.92	6.75
I T 0N	10	9.42	7.42^{b}	3.79	5.83	3.88	6.77^{bc}	4.50	5.50	7.19
I T FN	11	9.22	7.48^{b}	3.77	5.41	3.31	6.52^{abc}	4.25	5.38	6.97
I NT FN	8	8.66	6.59^{ab}	3.59	5.13	3.56	6.38^{abc}	3.78	5.34	6.69
I NT SN	9	8.52	6.33^{ab}	3.56	5.02	3.98	6.33^{abc}	4.46	5.46	6.42
I T SN	12	8.59	6.08^{a}	3.42	4.88	4.36	6.17^{ab}	4.58	5.50	6.56

Significant differences by Tukey HSD at p = .05 denoted by dissimilar superscripts.

Table 5: AROMA ATTRIBUTES:

Means Across 3 Levels of Nitrogen Application Across All Levels of Irrigation and Tillage

Field treatment	*Aroma OI*	*Fruity*	*Floral*	*Spiciness*	*Vegetative*	*Earthy/musty*
No Nitrogen	8.69	6.88	4.63	5.04	3.81	4.11
Soil Nitrogen	8.81	6.57	4.26	4.58	3.82	4.62
Foliar Nitrogen	8.79	6.89	4.64	4.95	3.78	4.16

Means of Tillage vs. No Tillage Across All Levels of Nitrogen and Irrigation

Field treatment	*Aroma OI*	*Fruity*	*Floral*	*Spiciness*	*Vegetative*	*Earthy/Musty*
Not tilled	8.73	6.66	4.44	4.75	3.82	4.41
Tilled	8.69	6.66	4.41	4.73	3.83	4.38

Means of Irrigated vs. Dry Wines Across All Levels of Nitrogen and Tillage

Field treatment	*Aroma OI*	*Fruity*	*Floral*	*Spiciness*	*Vegetative*	*Earthy/Musty*
Irrigated	8.67	6.59	4.38	4.77	3.89	4.48
Dry	8.84	6.93	4.62	4.94	3.74	4.15

Table 6: FLAVOR ATTRIBUTES

Flavor Means Across 3 Levels of Nitrogen Application Across All Levels of Irrigation and Tillage

Field treatment	*Fruity fl*	*Floral fl*	*Spicy fl*	*Veg fl*	*Acidity*	*Bitterness*	*Astringency*	*Body*
No Nitrogen	7.31	3.76	5.42	3.77	6.61	4.22	5.61	6.84
Soil Nitrogen	6.69	3.45	5.06	3.84	6.23	4.25	5.60	6.60
Foliar Nitrogen	7.11	3.75	5.19	3.63	6.32	4.17	5.43	6.82

Flavor Means of Tillage vs. No Tillage Across All Levels of Nitrogen and Irrigation

Field treatment	*Fruity fl*	*Floral fl*	*Spicy fl*	*Veg fl*	*Acidity*	*Bitterness*	*Astringency*	*Body*
Not tilled	7.02	3.61	5.33	3.74	6.37	4.31	5.53	6.86
Tilled	7.07	3.65	5.32	3.72	6.35	4.23	5.48	6.82

Flavor Means of Irrigated vs. Dry Wines Across All Levels of Nitrogen and Tillage

Field treatment	*Fruity fl*	*Floral fl*	*Spicy fl*	*Veg fl*	*Acidity*	*Bitterness*	*Astringency*	*Body*
Irrigated	6.83	3.64	5.18	3.78	6.39	4.34	5.50	6.75
Dry	7.19	3.66	5.26	3.74	6.35	4.11	5.57	6.73

Table 7: Winemaker Panel Color Evaluation Data

Field treatment	Overall color intensity	Purple hue	Garnet hue
D NT 0N	9.61	7.25	6.21
D T 0N	8.55	6.24	6.44
D NT FN	6.34	6.52	6.52
D T FN	9.07	6.59	6.59
D NT SN	8.90	6.50	6.76
D T SN	10.73	8.59	6.61
I NT 0N	8.50	6.17	6.47
I T 0N	8.72	6.10	6.42
I T FN	8.84	6.44	6.67
I NT FN	9.00	5.79	6.21
I NT SN	9.50	8.20	7.40
I T SN	9.42	8.00	6.50

Treatment	Overall color intensity	Purple hue	Garnet hue
Dry	9.02	6.68	6.48
Irrigated	8.74	6.34	6.49

Treatment	Overall color intensity	Purple hue	Garnet hue
No Nitrogen	8.75	6.50	6.25
Foliar Nitrogen	8.61	6.29	6.56
Soil Nitrogen	9.63	7.21	6.62

Treatment	Overall color intensity	Purple hue	Garnet hue
Tilled	9.01	6.73	6.46
Not Tilled	9.03	6.64	6.50

Appendix 1: Ballot Used During Winemaker Panel Evaluation of 1999 BLPN Wines.

Winemaker Evaluation Panel of 1999 Pinot Noir Wines

Panelist#_____

Session# _____

Sample#						
AROMA						
Overall intensity						
Overall fruitiness						
Overall Floral						
Overall Spiciness						
Overall vegetative						
Earthy/Musty						
FLAVOR						
Overall Intensity						
Overall fruitiness						
Overall Floral						
Overall Spicy						
Overall Vegetative						
Acidity						
Bitterness						
Astringency						
Body						