Oregon Wine Advisory Board
Research Progress Report

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Evaluation of Nitrogen Deficiencies in Oregon Grapevines, Musts and Wines

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INTRODUCTION

Stuck and slow fermentations are a major concern of winemakers. If the levels of fermentable nitrogen in juice are too low, fermentations will be slower and may stop or 'stick' before all the fermentable sugar is utilized by the yeast. Sluggish and stuck fermentations are also sometimes accompanied by production of hydrogen sulfide and other 'reduced' sulfur odors. Winemakers often report problem fermentations with winegrapes from specific vineyard sites over the course of several vintages. The objective of this research is to evaluate the nitrogen content and nutritional status of Oregon grapevines and winegrapes from specific vineyard sites for three vintages and to evaluate the effects of nutritional supplementation on fermentation behavior. Recognition of grapevine nutritional deficiencies during the growing season may allow for early prediction of nitrogen deficiencies in juice at harvest and allow correction by vineyard management practices such as nitrogen fertilization and by nutritional supplementation at harvest. Analysis of the yeast available nitrogen content in juice at harvest and the evaluation of the effects of nutrient supplementation will help winemakers to make more knowledgeable decisions on fermentation management.

PROCEDURES

Petiole samples were collected in 1998 from 46 commercial vineyard blocks in the Willamette Valley at bloom and again at veraison. For each sampling time, petiole samples were collected to provide a representative sample of each vineyard block. Each sample consisted of 100 petioles from randomly selected vines uniformly distributed throughout the block. Petioles were analyzed for nitrate nitrogen and nine other macronutrients and micronutrients. Juice samples from these vineyard blocks were taken at harvest and were analyzed for fermentable nitrogen content composed primarily of ammonia (NH3) and the alpha-amino acids present. The alpha amino acid content was measured using an OPA/NAC spectrophotometric assay and the ammonia content was analyzed using an enzymatic assay (Sigma diagnostic kit). Correlation analysis was conducted on petiole nitrogen levels and juice fermentable nitrogen content at harvest. A range of commercial nutritional supplements added to nitrogen deficient juice prior to fermentation was evaluated for the effects on fermentation rates and wine quality.

RESULTS AND DISCUSSION

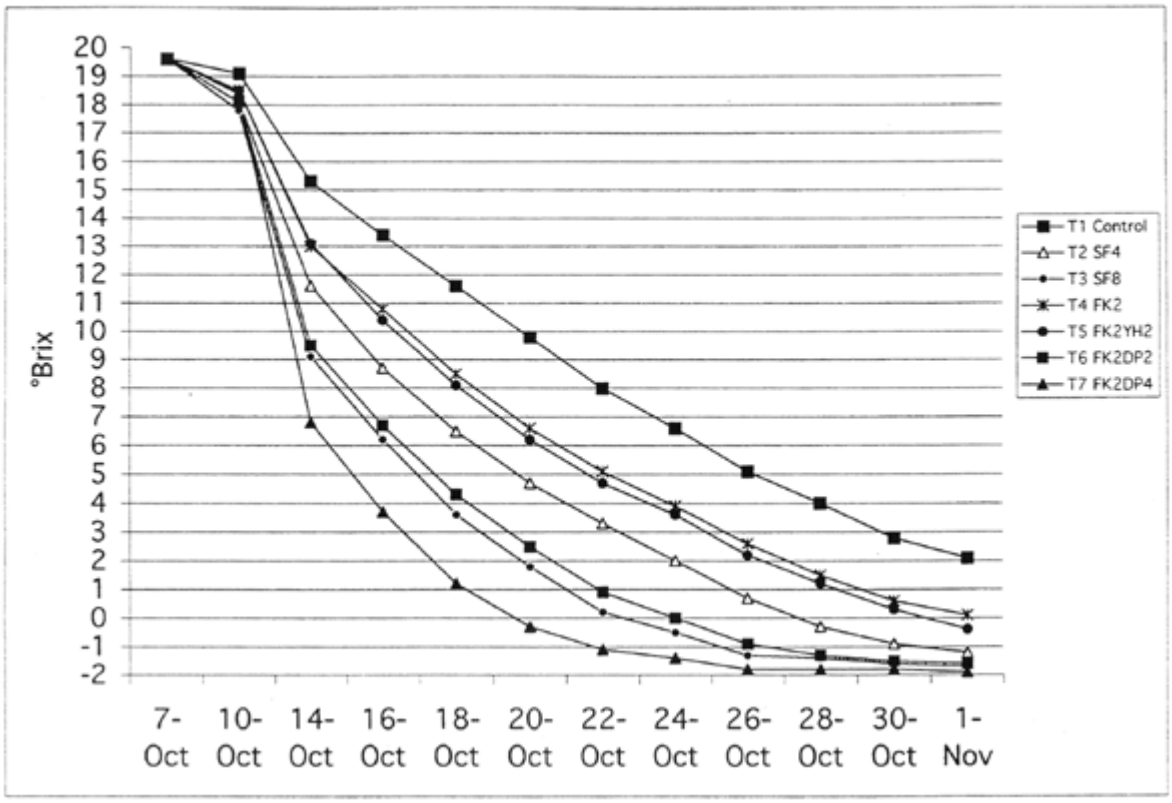
Petiole analysis of macro- and micronutrients indicated that a high percentage of vines were deficient in nitrogen (87% at bloom, 96% at veraison), based on bloom-time standards for California and veraison standards for Oregon. Other macro- and micronutrients were found to be at adequate levels in almost all samples. More sample were nitrogen deficient in 1998 compared to 1997, and there was a good correlation (r = 0.85) between years for total percent nitrogen levels in petioles at veraison.

Of the 46 blocks sampled for petioles, 33 provided must samples. Correlation analysis was conducted on petiole and must nitrogen level at the two sampling times. Petiole nitrate nitrogen levels at veraison were well correlated with must nitrogen (r = 0.86), whereas bloom nitrate levels were not well correlated (r = 0.42) with must nitrogen. These results are opposite of the 1997 results for which bloom nitrate levels were better correlated (r = 0.80) than veraison levels (r = 0.48). Total percent nitrogen levels were more consistently correlated with must nitrogen levels in 1997 and 1998, with r values ranging from 0.52 to 0.79 over the two sampling times.

Juice samples taken at harvest were analyzed for ammonia and alpha amino acid content in order to estimate the yeast assimilable nitrogen content (YANC). Recommendations for fermentable nitrogen levels necessary for healthy fermentations vary from as low as 140 to as high as 500 mg N/L or more. Samples (58) taken at harvest during the 1997 vintage ranged from 45 to 442 mg N/L YANC (average 178) with 52 % of the samples less than 140 mg N/L. By variety, 80% of the Chardonnay samples (15), 37.5% of the Pinot gris and Pinot blanc samples (8), and 40% of the Pinot noir samples (35) contained less than 140 mg N/L YANC at harvest. Samples (59) at harvest in 1998 ranged from 63 to 375 me, N/L YANC (average 133) with 68% less than 140 mg N/L. By variety, 93% of the Chardonnay samples (14), 25% of the Pinot gris and Pinot blanc samples (4), and 61% of the Pinot noir samples (41) contained less than 140 mg N/L YANC at harvest.

Commercial nitrogen supplement preparations, including Superfood, Fermaid K, PL-50 yeast extract, yeast hulls and diammonium. phosphate (DAP), were evaluated for their contribution to the yeast assimilable nitrogen content (YANQ and their effects on fermentation behavior in a nitrogen deficient Chardonnay juice (YANC 45 mg N/L). Settl ed juice was purchased from a commercial Oregon winery during the 1997 vintage, and frozen until use in August 1998. The juice was thawed, 35 mg/L sulfur dioxide added, and separated into 14 treatments which were run in duplicate (3) gallons each). The treatments included a control with no supplementation. Superfood was added at 4 and 8lbs/1000 gal. Fermaid K was added at the rate of 2lbs/1000 gal with and without the addition of yeast hulls at 2lbs/1000 gal, and DAP at 2 and 4lbs/1000 gal. DAP was added at a rate of 2, 4, and 8lbs/1000 gal. Additional treatments included 4lbs/1000 gal DAP + 2lbs/1000 gal yeast hulls, 4lbs/1000 gal DAP + 1lb/1000 gal PL-50 (yeast extract), 4lbs/1000 gal DAP + 2g/1000 gal thiamine, and 4lbs/1000 gal DAP + 2 g/1000 gal thiamine + 2lbs/1000 gal yeast hulls. The supplements were well-dissolved in a small amount of juice, then added to the treatment and sampled. Fermentation with CY 3079 yeast (250mg/L) was carried out at 20°C. Fermentations lasted from 17 to 42 days, and were considered complete when they reached -1.8°Brix. Fermentation profiles are shown in figures 1 and 2.

Figure 1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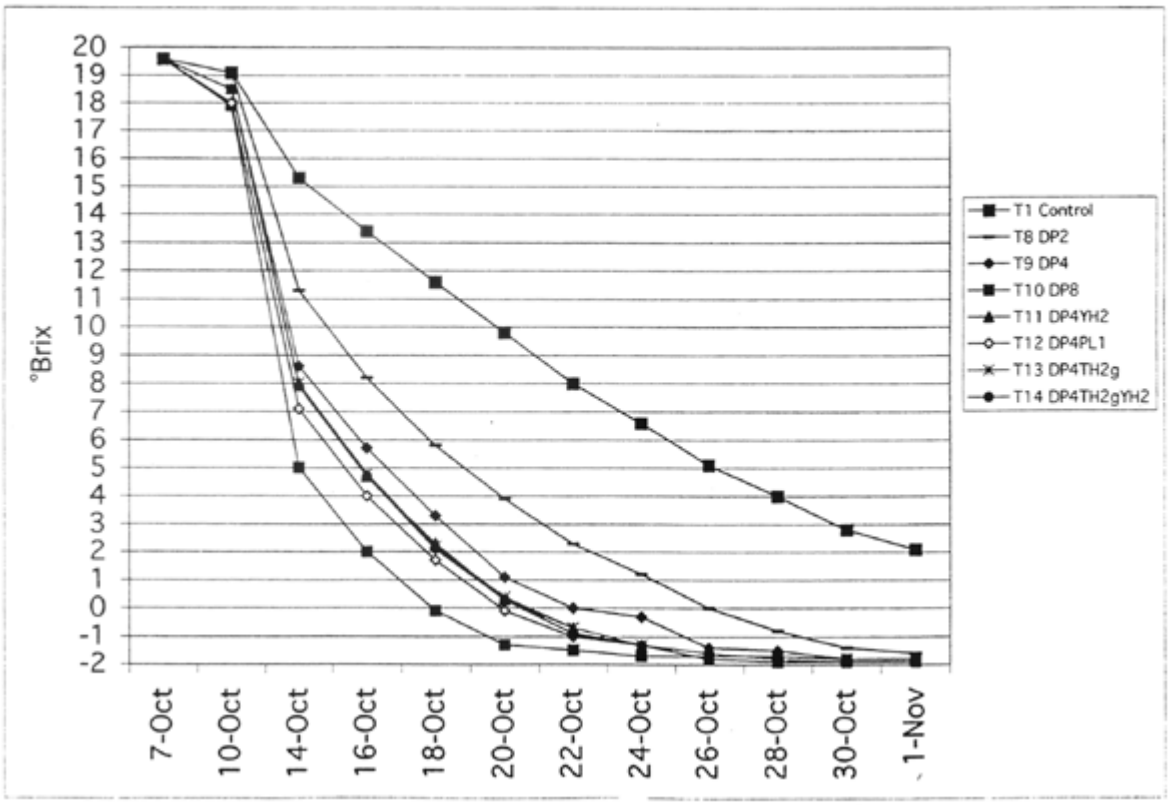
28-Oct
30-Oct
1-Nov
T1 Control
T2 SF4
T3 SF8
T4 FK2
T5 FK2YH2
T6 FK2DP2
T7 FK2DP4

Figure 2



The YANC of the juice after supplement addition prior to fermentation is shown in Table 1. The addition of yeast extract (PL-50) at 2 lbs/1000 gal resulted in a moderate increase in fermentable nitrogen content due to alpha amino acid content. The addition of Superfood showed only a slight increase in alpha amino acid content and addition of Fermaid K showed no increase. Both Superfood and Fermaid K additions, however, showed increases in mg N/L from ammonia. The increase in fermentable nitrogen content was greatest for the DAP additions due to increases in ammonia content. The addition of 8lb s/ 1000 gal DAP increased the fermentable nitrogen content (YANC) from 4 5 mg N/L in the control to 222 mg N/L with the mg N/L from ammonia increasing from 6 to 176 mg N/L. The YANC content was inversely related to days to dryness, with the control (lowest YANC, 45 mg N/L) taking 42 days. The addition of 8lbs/1000 gal DAP with the highest YANC (222 mg N/L) completed fermentation in 17 days. Juice supplemented with Superfood at 4 and 8 lbs/1000 gal fermented more quickly than with Fermaid K at 2 lbs/1000 gal, however, Fermaid K (2 lbs/1000) + 4 lbs/1000 gal of DAP finished fermentation faster (19 days) than juice supplemented with either Superfood at 4 and 8 lbs/1000 gal or with 4 lbs/1000 gal of DAP alone. DAP (4 lbs/1000 gal) with additions of yeast hulls, yeast extract, and thiamine also completed fermentation within 19-21 days, compared to 23 days with DAP alone.

Table 1.

Treatment*		mg N/L NOPA	mg N/L as NH3	mg N/L YANC	Days to dryness
T1	Control	39	6	45	42
T2	Superfood 4 lbs	45	31	76	29
T3	Superfood 8 lbs	48	59	107	25
T4	Fermaid K 2 lbs	38	21	59	33
T5	Fermaid 2 lbs + Yeast Hulls 2 lbs	35	17	52	33
T6	Fermaid K 2 lbs+ DAP 2 lbs	41	65	106	25
T7	Fermaid K 2 lbs+ DAP 4 lbs	40	110	150	19
T8	DAP 2 lbs	42	52	94	25
T9	DAP 4 lbs	43	86	129	23
T10	DAP 8 lbs	46	176	222	17
T11	DAP4 lbs+ 2 lbs Yeast Hulls	42	90	132	19
T12	DAP 4 lbs+ PL-50 1 lb	58	95	153	19
T13	DAP 4 lbs+ 2 g Thiamine	47	100	147	21
T14	DAP 4 lbs + 2 g Thiamine + 2 lbs Yeast Hulls	48	88	136	19

*average of duplicate lots

The next phase of this research will be to analyze the YANC of samples which were taken from the treatments during the course of fermentation and frozen, to determine how much and when the fermentable nitrogen was utilized by the yeast. Experimental wines from this trial will also be analyzed for aroma and flavor using an industry winemaker panel in the OSU Sensory Sciences Laboratory to assess whether any of the nutritional supplements affected wine quality.