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Evaluation of Nitrogen Deficiencies in Oregon Grapevines, Musts, and Wines

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INTRODUCTION

Over the last several years 'stuck' and 'sluggish' fermenations have become a ma or concern of winemakers in Oregon as well as in Washington and California. During the 1996 vintage we began a preliminary survey of Oregon musts and juices at harvest and showed that many were low or marginal in fermentable nitrogen content. The readily fermentable nitrogen content in juice and musts is composed primarily of ammonia (NH4) and the alpha-amino acids present (particularly arginine, serine, glutarnate, threonine, aspartate, and lysine). An approximation of the total yeast fermentable nitrogen is taken as the sum of the ammonia content plus the alpha-amino acid content. If the levels of fermentable nitrogen present in juice or must at harvest are too low, the total yeast cell biomass produced will be low and fermentations will be slower and may stop or 'stick' before all the fermentable sugar is utilized. Sluggish and stuck fermentations are also sometimes accompanied by production of hydrogen sulfide and other 'reduced' sulfur odors. Some researchers have also reported an increase in fruity aroma intensity and wine quality with moderate nitrogen supplementation (Rapp and Versini, 1995; Vos, 1982). Many of the alpha amino acids are metabolized by yeast to produce important aromatic alcohols and esters. Nitrogen supplementation in the winery and in the vineyard need to be evaluated for their effects on wine aroma, flavor, and wine quality.

Recommendations for the amount of fermentable nitrogen needed by yeast for healthy fermentations vary from as low as 140 mg (N)/L (California) and 300 mg (N)AL (Burgundy) to as high as 500 mg (N)/L or more. Lower recommended levels are based upon observations of the minimal levels usually required for timely completion of alcoholic fermentation to dryness. Higher recommendations are generally based upon the amount of nitrogen required to obtain the maximum biomass of yeast and maximum fermentation rates.

Grape juice nitrogen status is known to vary with variety, vineyard site, and the climate (vintage). Winemakers often experience fermentation problems with fruit from specific vineyard blocks, which often vary in severity with different vintages. Other factors that may affect nitrogen status include grape maturity, crop load, and the condition of fruit at harvest. The presence of rot, mold, and the growth of indigenous yeast and bacteria can significantly reduce the fermentable nitrogen content of fruit at harvest.

The objective of this research is to evaluate the nitrogen status of Oregon grapevines and winegrapes

over several vintages. Petiole nitrogen analysis at bloom and at veraison will be measured and correlated with nitrogen content of fruit at harvest and may allow the development of an early prediction method for nitrogen status of fruit at harvest. Analysis ofjuice and must at harvest will allow winemakers to make more knowledgeable nitrogen supplementations prior to fermentation in order to avoid potential problem fermentations. The effects of nitrogen supplementation on fermentation behavior, fermentation rates, and aroma, flavor and wine quality will be also be evaluated.

METHODS:

During the 1997 vintage, 64 juice and must samples at harvest were analyzed for alpha amino acid content and ammonia levels in cooperation with 12 commercial Oregon wineries. Nitrogen supplements were also made to several of the juice and musts prior to and during fermentation and the their effectiveness in augmenting fermentable nitrogen levels is being evaluated. The alpha amino acid content (NOPA) was measured using a new spectrophotometric assay recently reported by Dukes and Butzke (1996). The ammonia content was analyzed using an enzymatic assay (Sigma diagnostic kit).

Petiole samples were collected from 41 commercial vineyard blocks in the Willamette Valley, 27 of which also supplied must samples for analysis at harvest. Petiole samples were collected 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 total nitrogen.

CURRENT PROGRESS AND DISCUSSION

During the 1997 vintage, 64 Oregon juice and must samples were analyzed for alpha-amino acid content and ammonia levels. The samples consisted primarily of Pinot noir, Chardonnay, and Pinot gris. The alpha-amino acid content ranged from 14-177 mg (N)AL with an average of 58. The ammonia levels ranged from 0-71 mg (N)/1L with an average of 24. The total fermentable nitrogen taken as the sum of the alpha-amino acid and ammonia content ranged from 16-241 mg (N)/L with an average of 93. The percentage of samples analyzed with less than the recommended minimum of 140 mg (N)AL of fermentable nitrogen was 78%, including 70% of the Pinot noir samples (40), 78% of the Pinot gris samples (9), and 100% of the Chardonnay samples (15) see Figs. 1, 2, and 3. In comparison, the fermentable nitrogen levels in 1996 were roughly double that of the 1997 averaging 185 mg (N)/L. Of 43 musts analyzed in 1996, 17 (39%) were less than 140 mg (N)/L. Samples ranged from 38 to 500 mg (N)/L. The alphaamino acid content ranged from about 43 to 378 mg (N)/L with an average of about 137 mg/L and the ammonia content ranged from 5 to 145 mg/L with an average of 58 mg/L. Many of the juice and must samples in 1997 came from the same vineyard blocks as measured in 1996.

Fig. 1

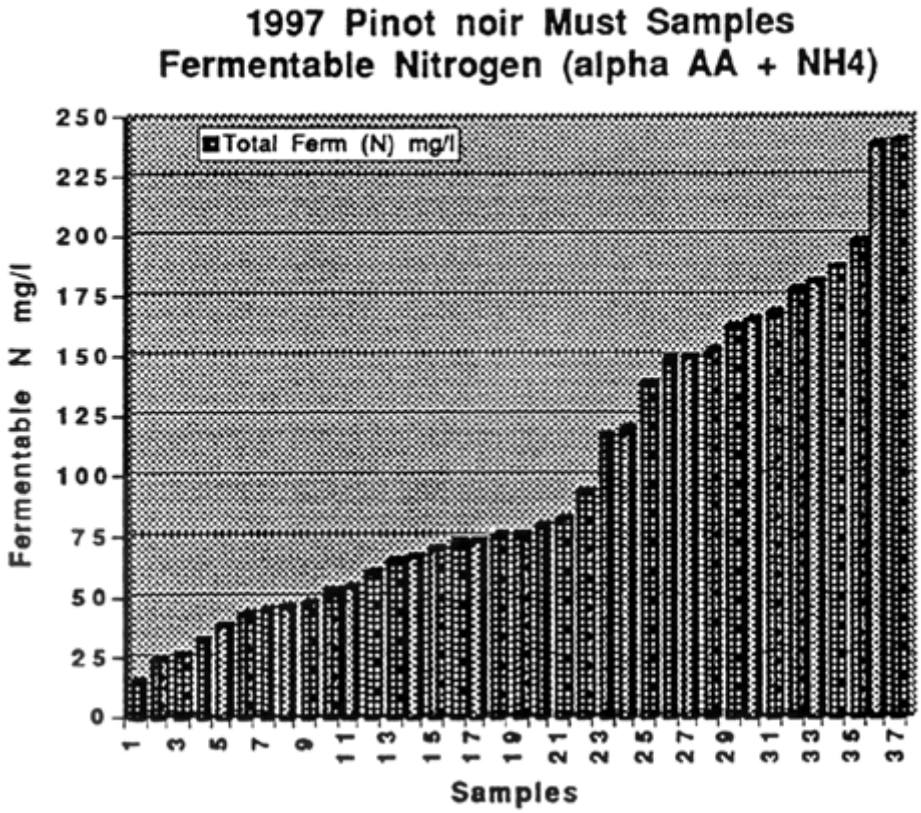

1997 Pinot noir Must Samples
Fermentable Nitrogen (alpha AA + NH4)
Total Ferm (N) mg/l
Fermentable N mg/l
250
225
200
175
150
125
100
75
50
25
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
Samples

Fig. 2

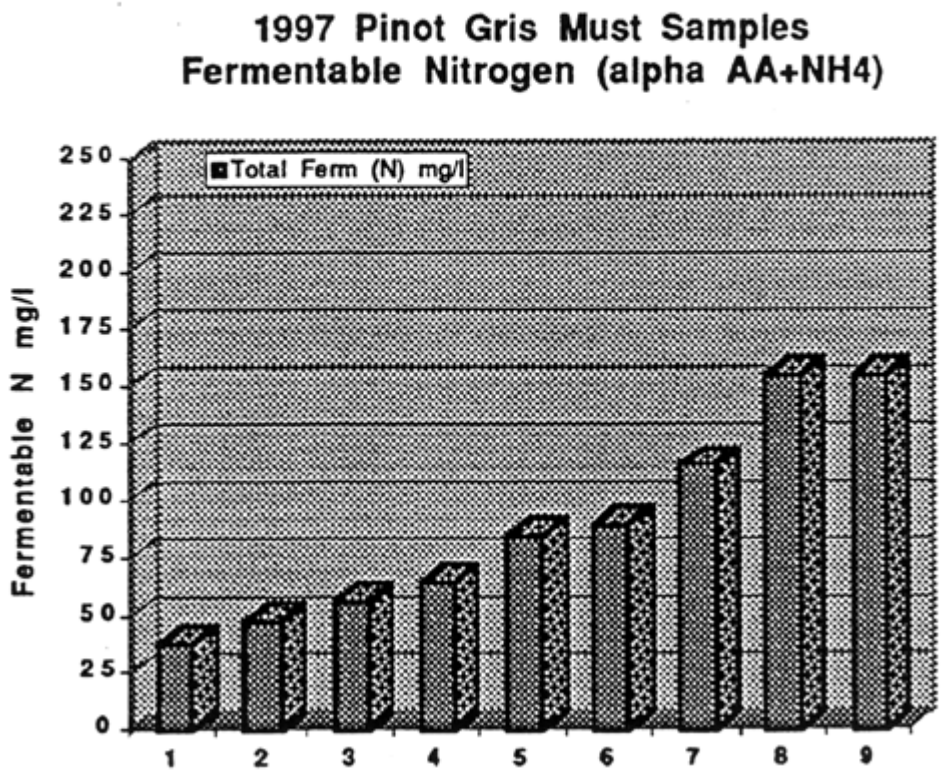
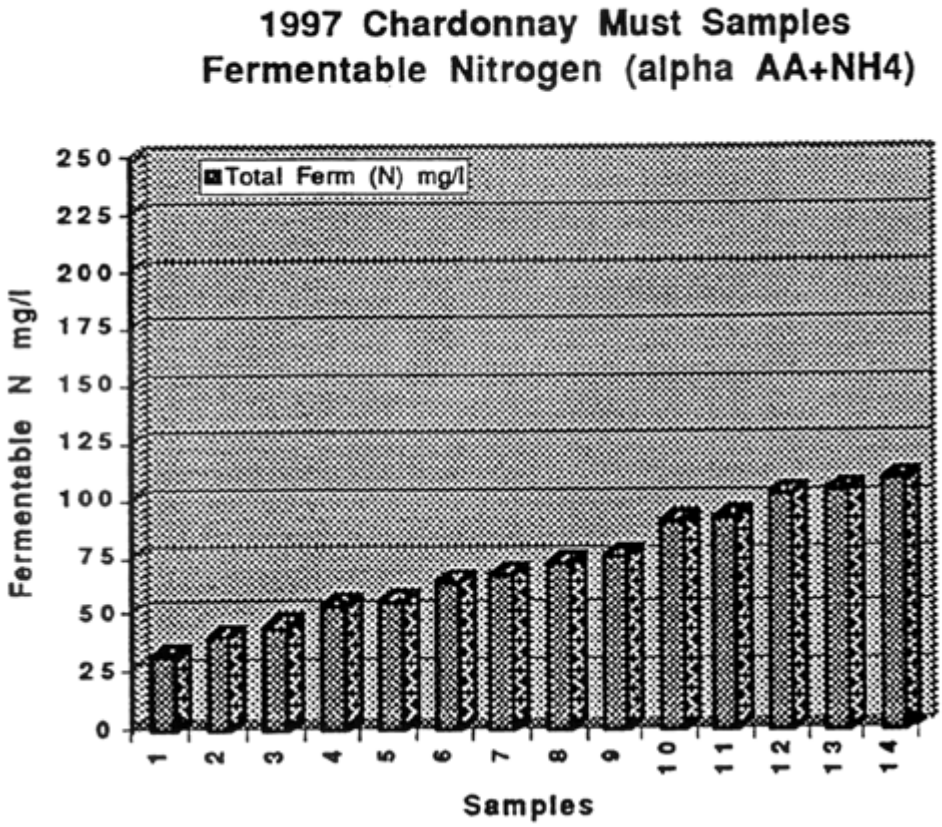

1997 Pinot Gris Must Samples
Fermentable Nitrogen (alpha AA+NH4)
Total Ferm (N) mg/l
Fermentable N mg/l
250
225
200
175
150
125
100
75
50
25
0
1
2
3
4
5
6
7
8
9

Fig. 3



Additional work to be done in 1998 includes evaluating the effectiveness of a range of commercial supplements for increasing the fermentable nitrogen content ofjuice and musts and their effects on fermenation behavior, fermentation rates, and wine quality. Experimental wines with and without nitrogen supplements will be made and the new wines will be analyzed for aroma and flavor using an industry winemaker panel in the OSU Sensory Sciences Laboratory.

Petiole analysis results for 1997 are reported for 27 vineyard blocks for which juice samples at harvest were also analyzed. Petiole nitrate nitrogen levels at bloom were somewhat correlated (r = 0.6107) with veraison petiole nitrate. Bloom petiole nitrate level was better correlated (r = 0.8019) with total fermentable nitrogen than was veraison nitrate level (r = 0.4783). A similar relationship was seen between petiole nitrate and alpha amino acid content (NOPA). Bloom petiole nitrate was well correlated (r = 0.8022) with NOPA, while veraison nitrate levels and NOPA had a correlation coefficient of 0.4966. Interestingly, when the 12 blocks of Pinot noir were separately analyzed, petiole nitrate nitrogen levels at bloom were well correlated (r = 0.8580) with veraison petiole nitrate. Bloom petiole nitrate level was much better correlated with total fermentable nitrogen (r = 0.8713) and NOPA (r = 0.8693) than was veraison nitrate level with total fermentable nitrogen (r = 0.4583) and (0.4859) NOPA.

The following information will be collected for each block: variety, clone, rootstock, previous soil and petiole test results, fertilization practices, floor and canopy management practices. Separate statistical analyses will be performed to determine if any of the vineyard factors (variety, clone, etc.) correlates with N levels in petioles and fruit at harvest.

LITERATURE CITED:

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