Final Plain Language Research Summary - AgriScience Grape & Wine Cluster 2018-2023

Activity: *Nitrogen management in viticulture and enology: Improving grape and wine quality and enhancing vineyard sustainability through precision management of N and strategies to increase natural yeast assimilable nitrogen in grapes and wine*

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Nitrogen directly impacts grape quality by affecting vine vigour, fruit set and maturation, crop load and pressure from diseases and insects. The impact of fruit nitrogen content on fermentation is through the yeast's requirements for ammonium and amino acids for growth, and as a byproduct amino acids are metabolized by the yeast into flavours and aromas which influence wine quality. We examined how soil and foliar N applications influence the ratios of YAN components (ammonium and 20 alpha amino acids) in grapes and how they impact fruit and wine quality. Application of foliar nitrogen in two commercially important varieties (Pinot gris and Cabernet Sauvignon) resulted in up to a two-fold increase in fruit nitrogen content and had an impact on amino acid profiles. These results were consistently achieved over four years. Fermentation studies indicate that the differences in fruit amino acid profiles and total nitrogen content from treatments applied in the field trials impacted fermentation and wine quality.

Precision management of nitrogen in vineyards is used to improve consistency in grape quality and vine growth throughout a vineyard block. Identifying areas with low or high nitrogen status in grapevines is challenging when done on a large scale. It takes grapevines more than one season to adjust to changes in nitrogen availability. In the second year of the field nitrogen trials work on developing imaging tools to predict nitrogen status began. Using different imagers (red edge, RBG, infrared, lidar) and techniques (NADR, cloud point) with an aerial drone we identified eleven indices with significant correlations to nitrogen status in grapes and leaves. Additionally, using three-dimensional modelling we developed a method to image the sides of the vine canopy instead of the narrow top which provided more accuracy.

The work conducted in this activity provides new tools and an understanding of nitrogen management in both the vineyard and winery. This will improve the sustainable use of nitrogen fertilizer in vineyards and reduce the requirement for using diammonium phosphate (DAP) for winemaking.

Objective 1: Soil and foliar nitrogen (N) application to determine the impact on and relationships among amino acid profiles, yeast assimilable nitrogen content, fruit quality, bud hardiness and flavonoids (pigment and tannin)

Two foliar nitrogen application trials with Pinot gris and Cabernet Sauvignon were completed in industry vineyards. Five treatments were applied (three rates of fertigated N or two rates of late foliar N) , vine and fruit measurements were collected and fruit from both trials was harvested and used for winemaking in objectives 4 and 5. Chemical analysis of the fruit is almost complete. The remaining samples are from the final season. Results from all three years of the field trials show significant

differences (up to two-fold differences) in berry nitrogen and amino acid content among treatments without affecting vine vigour or general berry composition (sugar and acid). Different amino acid profiles were recorded among treatments which should result in different flavour profiles in the wines. There were no differences in bud hardiness or vine vigour among treatments which indicates the elevated N content was not detrimental. To increase fruit yeast assimilable nitrogen later in the season to avoid vigour and herbaceaousness its recommended that 2% urea can be applied two or three times at two-to-three-week intervals starting at 10o Brix.

Objective 2: Evaluate the effectiveness of N application to alleviate leaf roll virus symptoms of reduced yield and maturity

This objective was completed in 2021. We concluded that fertilizing with nitrogen does not impact virus symptoms of delayed maturation or reduced yield.

Objective 3: Spectral imaging and precision management for vineyard N status using UAVs (drones)

Pinot Gris and Cabernet Sauvignon vineyard blocks (two different sites) were imaged using a UAV with multispectral, infrared and RGB cameras. Multiple flights were conducted each year. At the same time, direct multispectral measurements of leaves were taken and leaf samples were analyzed for N status and pigments. Nitrogen and pigment analysis of leaves and fruit are complete. During the project, there were environmental challenges for aerial imaging which included smoke, wind and proximity to wildfires. Despite these challenges, we were able to develop models for predicting vine N status with an acceptable level of accuracy. Using NADIR and point cloud imaging, 11 indices were significant for predicting vine N status remotely. The data was correlated to both leaf colour and directly to the nitrogen status (nitrogenous compounds) which is a step forward compared with the industry standard methods of inference through using leaf colour alone.

Objective 4: Evaluate soil applied N with late foliar N application in the field for impacts on wine quality including amino acid profiles, fermentation kinetics, sensory evaluation, wine protein content and compounds related to N metabolism

Wines were produced from the field trials conducted in objective 1. Chemical analysis of the current wines including amino acids and ammonium, nitrate and other compositional components are almost complete. Sensory trials will be conducted on the 2022 wines after they have been in the bottle long enough to reduce bottle shock and for maturation. Varietal differences in response to foliar N application in the field are present and treatment effects on N content in the finished wines indicate quality differences are present. Amino acid content in the must and wine from foliar N treatments was elevated which coincides with the elevated yeast assimilable nitrogen content evaluated in objective 1. Sensory evaluation of wines from previous years indicate less vegetative and more fruity characteristics with foliar N applications. Yeast assimilable N was elevated enough with foliar N application to complete fermentation without supplemental DAP additions while maintaining or enhancing wine quality.

Objective 5: Determine the influence that amino acid composition and diammonium phosphate additions have on wine flavour, aroma profiles and fermentation kinetics

This objective has been partially met. Investigation of amino acid composition and its influence on quality in Pinot gris and Cabernet Sauvignon is almost complete. Amino acid analysis of the 2022 vintage will be completed shortly. We have significant differences in amino acid profiles and we will investigate

the sensory impact on 2022 wines when we complete the sensory analysis. Fermentation kinetics were not affected by treatments.

Objective 6: Evaluate YAN requirements in icewine and high sugar musts with respect to recent findings on yeast nutrition such as biotin, pantothenic acid and other vitamin requirements

This objective was deferred. We harvested grapes for icewine trials to be conducted this fiscal year but due to time constraints and a shortage of student help we were not able to complete this component before the end of the project. We would like to continue this work in the new fiscal year since it is partially done.