North Dakota Research Update

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Background and Rationale: North Dakota is a unique place to attempt to grow cold-hardy grapes as North Dakota led the nation in the production of all dry edible beans, pinto beans, canola, flaxseed, honey, oil sunflowers, all wheat, Durum wheat, and spring wheat. North Dakota also ranked second in the production of black beans, navy beans, lentils, dry edible peas, all sunflowers, and non-oil sunflowers. North Dakota has also been nationally recognized as the state having the greatest potential to produce energy through wind power. Lastly, the 30-year average monthly temperature goes from a low of 10.6 °F in January to a high of 69.1 °F in July. These three issues would have convinced many to give up on growing winegrapes, but the response has been just the opposite, with more growers wanting to grow grapes and wanting to know how to grow successfully year after year. For the grant our research efforts were supposed to be the NE1020 variety trial and optimal mineral nutritional and soil management. However, we have also conducted research on environmental stability in the fall acclimation response of cold hardy interspecific hybrid winegrapes, weed control options during establishment of cold hardy winegrapes, and the effects of trellis systems and leaf pulling on Frontenac. Below are three abstracts where this research was presented during 2015.

Environmental stability in the fall acclimation response of cold hardy interspecific hybrid wine grapes

Cultivar development has allowed commercial wine production in North Dakota. Among the most grown cultivars in the region are Frontenac Gris, Marquette, and St. Croix. Though these cultivars have been adopted, some uncertainty exists in their year to year reliability and performance. A key factor in determining reliable performance is fall acclimation to winter conditions. In a three year study, vine acclimation response was tract at two locations in North Dakota for the three cultivars. Seven acclimation predictors were evaluated at each location for each half-hour decrease in photoperiod (15 – 12 hours daylight). Principal components analysis was used to reduce the seven predictor variables to four latent variables contributing 42.98%, 25.22%, 14.49%, and 8.15% of the total variability of the dataset respectively. Through correlations with the original dataset, it was determined that Factor 1 was primarily associated with bud and periderm maturation, Factor 2 was associated with growth, Factor 3 was associated with the percentage of nodes having laterals, and Factor 4 was associated with tip abscission. All factors were evaluated using ANOVA as a randomized complete block design with three replications, six environments, three cultivars, and seven repeatedly measured photoperiods. Factors 1, 2, and 4 were significant for genotype by environment by photoperiod interaction. Eberhart and Russell (1966) stability analysis was conducted to determine the relative stability of each cultivar in each photoperiod that was found to have significant variation by analysis of simple effects. Factor 1 was found to have significant variation when the photoperiod dropped below 13.5h of daylight. During this period no cultivar's stability slope was significantly

different than 1, however the deviations of points from the regression was significantly less in St. Croix when compared to all other cultivars at 12 and 12.5h of daylight. For factor 2, significant variation was found in genotype by environment combinations for photoperiods from 15 to 14h daylight. All genotypes were unstable in early fall when the photoperiod was 15h daylight. Frontenac Gris was stable in its response for all remaining photoperiods, however Marquette was not stable in its growth progress (b=1.6157) at photoperiod 14h daylight and St. Croix was not stable (b=0.7692) at photoperiod 14.5h daylight. Differences were found in the reaction of these commercially important wine grape cultivars in North Dakota in their acclimation response. These differences in reaction may give insight into the relative reliability of cultivars used in North Dakota.

Evaluation of Weed Control Options during Vineyard Establishment in North Dakota

Alternative weed control methods were tested in an experimental vineyard near Absaraka, ND for their ability to control annual weed species as well as for their effects on vine growth during establishment. The experiment was arranged in a randomized complete block design and analyzed as a two factor factorial including four white wine cultivars (Alpenglow, Brianna, Frontenac Gris, and LaCrescent) and six weed control methods (Landscape Fabric, Herbicide (glufosinate-ammonium, 2.3 L ha^{-1}, with flumioxazin, 420 g ha^{-1}) , black plastic, Straw Mulch, Tillage, and Turfgrass) with four replications. Weed counts and biomass were collected using a 929 cm^2 (1 ft^2) quadrat. Data was converted to a per m^2 basis for evaluation. Landscape fabric and straw mulch were the most effective and consistent in reducing weed biomass across months and years. Tillage had the highest weed biomass amounts throughout the study, while landscape fabric, straw mulch, black plastic, and herbicide had the fewest number of weeds present. Dormant pruning weights differed across seasons for cultivars and weed control methods. Frontenac gris had greater growth all three seasons (19.2, 119.3, and 336.8 g/plant, respectively) compared to the other cultivars. Vines within the black plastic mulch consistently had higher pruning weights all three years (23.3, 119.5, and 442.4 g/plant respectively) compared to vines in the other treatments. Turfgrass and straw mulch generally suppressed the growth of all cultivars during the three year study. Findings suggest that black plastic or landscape fabric may be viable weed control alternatives in North Dakota vineyards.

Frontenac Response to Training Systems and Leaf Removal.

Experiments were conducted in 2013 and 2014 to evaluate the effects of training systems and leaf removal on yield and quality for 'Frontenac', an interspecific hybrid wine grape, at a research vineyard near Absaraka, North Dakota. The experiment was structured as a randomized complete block design with split plot arrangement. The four training system treatments (Geneva double curtain (GDC), high cordon (HC), vertical shoot positioned (VSP), and four arm kniffin (4AK)), manipulated vine growth habit, fruit bearing zones, and sunlight interception, while four leaf removal treatments (at bloom, two weeks post bloom, veraison, and no removal), exposed ripening grape clusters to various degrees of sunlight. Data analysis indicated differences among training systems between years. GDC had a great change in yield between years, with the largest average yield among trellis systems in 2014 and the lowest average yield among trellis systems in 2013. Average cluster number per vine was greatest in GDC in 2014. Berry weights were greater across all trellis systems in 2014 compared to 2013. All trellis systems had a decreased average pH and average soluble solids, and increased average total titratable acidity in 2014 compared to 2013. These findings suggest further research is necessary to determine Frontenac response to training systems in North Dakota vineyards.

What the results mean:

- The results of modeling the interaction between photoperiod, environmental conditions, and interspecific grapes has identified two grapevine accessions that are consistently similar to *V. riparia* in their acclimation process, which will be used to guide further grapevine improvement for the producers of cold hardy grapes in regions similar to North Dakota.
- The results of the weed control trial will be helpful to new establishing vineyards as it offers a high-cost long-term as well as a reduced-cost alternative to the chemical applications and soil disrupting mechanical tillage practices currently applied.
- The results of the Frontenac training system and leaf pulling trial showed growers that the GDC training system has potential to increase fruit yield without influencing fruit parameters, and that leaf pulling will not improve fruit parameters.