AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2014 – 2015

TITLE: Investigating the extent of primary bud necrosis in Willamette Valley Pinot noir

RESEARCH LEADER: Patricia A. Skinkis, Ph.D., Viticulture Extension Specialist & Associate Professor, OSU

COOPERATORS: Rob Schultz, Stoller Family Estate Vineyard

SUMMARY:
A two-year field trial was conducted to determine whether Primary Bud Necrosis was the primary cause to low fruitfulness and low yields commonly observed in Pinot noir vineyards in western Oregon.

OBJECTIVES:

1. Determine if Primary Bud Necrosis is present in vines with varying vegetative vigor levels.
2. Compare bud fruitfulness assessments to shoot fruitfulness post-bud break.
3. Determine the relationship between fruitfulness and carbohydrates.
4. Determine if canopy shading contributes to Primary Bud Necrosis or low fruitfulness.

PROCEDURES:
Research was conducted in a commercial vineyard near Dayton, OR (Stoller Family Estate Vineyard). Vines were maintained per commercial standards except when noted below. The vineyard was planted in 1998 to Pinot noir clone 115 grafted to 101-14 rootstock at a 7'x 5' spacing (1245 vines/acre) in N-S oriented rows. Vines were trained to a cane-pruned double Guyot system with vertical shoot positioning. This block has been used for continuing research projects by the PI since 2007. Earlier stages of research used vineyard floor management practices to create competition for soil N, thereby altering vine vigor. Three levels of vine vigor (high, moderate-high, and moderate based on vine balance metrics) resulted from the following vineyard floor management practices that were employed during the study: tilled soil between rows (Tilled), perennial grass between rows (Grass), and alternating tillage and grass between rows (Alternate). Maintaining perennial grass alleyways has been effective in decreasing vine vegetative growth as observed by decreasing pruning weight, leaf area, and tissue N compared to Alternate and Tilled treatments over the years. The vineyard floor treatments in the main plots were replicated in a completely randomized design. There were five replicates of each treatment with eight vines. We originally proposed to look at the effect of a split plot experiment, including vineyard floor management x different crop levels. However, we did not modify crop level for the objectives outlined here to allow for more efficient data collection and to reduce experimental variables.

Objective 1: During dormancy each year, two canes from each of the eight vines were collected from each vineyard floor management treatment (Grass, Tilled and Alternate). The two canes were located in the canopy, arising from the 2-year old cane that was laid down at pruning the year prior. Dormant buds were analyzed by hand dissection under a stereomicroscope. In 2014, the buds were cut longitudinally but the method was changed to horizontal cuts in 2015, as the previous method led to underestimation of flower primordia. During 2014, a sub-set of buds were embedded and observed using compound light microscopy. The two methods of microscopy were evaluated to determine the best method of quantifying fruitfulness in buds. By early 2015, we determined that the best method for assessing bud fruitfulness was through hand dissection under a stereoscope and light microscopy was not pursued due to lack of efficiency required for the number of samples we wished to process.

Objective 2: During spring 2014 and 2015, fruitfulness was assessed in each plot in the vineyard. This was done by quantifying the number of flower clusters on shoots arising from each node on all treatment vines as soon as they were visible. This required multiple visits to the vineyard since flower cluster visibility can vary given variability in shoot developmental stages. These counts were conducted before shoot thinning began and allowed us to assess the number of shoots arising at each node and number of clusters present and compare them with data obtained from bud fruitfulness counts done during winter.

Objective 3: During dormancy each year two canes (in addition to those collected in Objective 1) were collected from each of the eight vines within all treatment plots. At the lab, the canes were divided into bud and internode sections for future analyses of total non-structural carbohydrates (TNC). Tissues are currently being stored at -80°C until they were freeze-dried, ground, and subsampled for TNC analyses. The TNC of these tissues will be analyzed using the method of Chow and Landäusser (2004) upon the completion of the field components of the study (spring 2016), as the project was expanded with further grant support during 2014-2016 (see section below). The TNC data will be analyzed statistically with bud fruitfulness and PBN data to determine potential impact on bud development.

Trunk and root cores were excised from each treatment plot during dormancy and leaf fall (end of the growing season) as proposed. After samples were collected from the field, they were placed on ice and transported back to the lab where they were cleaned in distilled water, dried, and stored at -80°C until ready for analysis of TNC as described above.

Objective 4: Incident sunlight (photosynthetically active radiation, PAR) in the canopy was measured each year using a ceptometer (LP-80, Decagon Devices, Pullman, WA). Measures were taken in three canopy zones, including basal, middle, and upper at 11:00 a.m., solar noon, and 3:00 p.m. during key phenological stages, including pre-bloom, BB size, pea-size berries, bunch closure, véraison, and ripening. These data provided background information about incident light within the canopy of the three vineyard floor management treatments. This is interesting information to have in interpretation of the data since canopy leaf area was nearly 50% lower in Grass compared to Tilled treatment vines, leading to different levels of sun exposure of the canopy and buds. The question we hoped to address, in part, was whether light

may be an influential factor in floral primordia development in buds as part of the differences observed in canopy size.

SIGNIFICANT ACCOMPLISHMENTS:
Working on bud fruitfulness is a new area of research for the PI. The funding of these early stages allowed PhD student, Alison Reeve, to conduct this research as part of her PhD thesis and to work out the details of the methodology. After the first year of the project, she was able to determine the best method by which to dissect buds, and data were more robust in the second year of data collection as a result. Methods were also determined for carbohydrate analyses in 2015. Although others have conducted similar assays in the past, methods needed to be validated for the different tissues being examined (internodes vs. buds). Having clear methods outlined for these objectives provide a framework to continue future research in this area.

Objective 1. Based on 2014 and 2015 dormant bud samples, Primary Bud Necrosis (PBN) is not a concern. Less than 3% of samples had PBN in both years, and there were no differences in presence/absence of PBN for the three vineyard floor management treatments, despite different levels of canopy growth and vine vigor within the different treatments. This is an important finding for Oregon producers since PBN has been previously associated with high vine vigor, particularly in cool climates in studies conducted elsewhere. Although there was a small percentage of PBN found in samples, browning of floral primordia and meristems was observed in some of the samples (estimated 30-40% of samples). The browning varied in size and location within the bud and did not appear to be associated with PBN. It is unclear what the browning is caused by or what it means for floral/fruit development, as this has not been reported in the literature for grape bud research to date. Both 2014 and 2015 were years of high fruitfulness and yield for vineyards in the region, so it may be possible that conditions were optimum for bud development in the prior 2013 and 2014 seasons when floral primordia were being initiated, making PBN less of a problem. Future research will help us determine whether certain seasons or factors (nitrogen, carbohydrate, etc) may lead to more PBN.

Bud mites were also observed within the bud during dissections. Many believe that bud mites, if present, will decimate buds and severely reduce fruitfulness and yields. There has been no published research in Oregon indicating the prevalence of bud mites, nor any thresholds. However, this research indicates that bud mites can be present in the buds without creating issues with fruitfulness or yields. Although mite numbers were not quantified per bud, it is possible that the mite numbers were not high enough to cause damage to the buds.

Objective 2. Higher actual fruitfulness was found in 2014 than was projected from floral primordia counts measured from bud dissections. It is not possible to form new primordia post-bud break, so this indicated that all floral primordia in the buds were not being detected with vertical bud dissection. In winter 2015, bud cuts were performed horizontally, and more floral primordia were quantified. About 76% of the inflorescence primordia found in the bud became actual inflorescences in spring 2015. In general there were no differences in the ratio of bud fruitfulness versus actual fruitfulness for the different vineyard floor management treatments

or for different node positions. This is an interesting finding, as it was hypothesized that there may be greater loss of fruitfulness due to higher or lower vigor or that bud age (position along the node) would impact fruitfulness due to developmental maturity of the primordia.

Objective 3. The TNC of dormant tissues (bud, internodes), trunk and root samples have not been completed at this point in reporting because of the additional objectives added to the research through receiving additional grant support. Samples from 2014 and 2015 have been collected and are being stored at -80°C until analysis. The first samples were run in 2015 to test the method and the remainder will be analyzed for this project in spring 2016. The data analyzed so far using 2015 samples indicates no significant relationships between bud total non-structural carbohydrates and fruitfulness or necrosis measures. As the concentration of TNC of internodes increased, there was an increase in the number of inflorescence primordia found in the primary bud, the whole bud (primary plus secondary bud), and of the entire node when there were nodes with multiple compound buds. This may suggest that higher vigor vines have greater potential for bud fruitfulness. However, future analysis of samples collected will provide stronger evidence to support the link between vine vigor and fruitfulness.

Objective 4. The low occurrence of PBN made it difficult to determine the potential impacts that light may have on PBN. However, light had some influence on fruitfulness, based on regression analyses, although a relationship was not found to exist between dormant bud fruitfulness and each timepoint that light was measured the prior season. Generally, there was decreased necrosis of buds in 2014 and 2015 with increased light measured in the canopy the season prior. However, differences in bud floral development and fruitfulness are likely a result of differences in vine vigor and nutrient status rather than directly due to light. This helps disprove some research done by others that suggests that light exposure of buds is directly related to fruitfulness.

BENEFITS & IMPACT:

There is a lack of scientific data on bud fruitfulness in cool climate grape cultivars. Many of the studies investigating bud development have been conducted on a very small scale (random sampling of vines) or under controlled conditions and were not conducted in the vineyard to understand influences of commercial production and climate on bud development and yield. Some studies suggest a lack of fruitfulness of lower (basal) buds, and this has driven grower preference for the more labor-intensive cane pruning method over spur pruning which requires less labor and may be mechanized. The research suggests that basal buds are fruitful and that spur pruning should not cause significant yield reduction for Oregon Pinot noir growers. Because spur pruning requires fewer labor steps and can be mechanized, it may be a way for growers to reduce vineyard production costs. Results of this work also suggest that bud fertility is highly correlated with actual fruitfulness and may be possible for growers to use this method to get an early estimate of yield potential during winter, rather than waiting for mid-late summer to gather those preliminary estimates as they currently do. Having this data earlier may help growers identify a potential problem with low fruitfulness and make necessary adjustments. For example, they may alter pruning timing and intensity (number of buds

retained) to ensure adequate yields or consider changes in management (fertilization, irrigation, etc.) to potentially enhance fruitfulness in future years.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:

A grant proposal was submitted to the Oregon Wine Board to expand upon the work proposed herein. A total of $71,291 was obtained from August 2014 to August 2016. This allowed for two more experiments to be developed to address the impact of canopy management practices (leaf removal and lateral shoot removal) on bud fruitfulness and to collect more field data in the main study proposed herein, including more time points for trunk and root samples and the analysis of both nitrogen (N) and TNC during critical phenological stages in the season to determine impact of N and carbohydrates on bud primordia development. Also, it allowed for three seasons of dormant bud sampling rather than two. These additional funds and objectives pushed some sample assessment into 2016 as a result.

FUTURE FUNDING POSSIBILITIES:

Because of the additional research funding obtained, the project objectives were expanded to include more data collection, leading to some of the work being delayed beyond the timeline of this grant which partially supported the full project. Research from this ARF and Oregon Wine Board funded work will be completed in 2016. The research results to date have provided us with information about bud fruitfulness that will help us define new objectives moving forward in 2017 and beyond. The physiological and climatic factors that lead to yield variability in Oregon continue to be an area of interest for wine grape growers in Oregon and other cool climate regions where yield variability is a concern. Funding may be possible through federal sources or through regional grape production grant programs such as the Unified Grant Management System for Viticulture and Enology. The PI plans to propose continuation of this work in 2017.