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Project Duration	Two Years
First Year Funding Request	**20,000**
Total Project Budget	40,000
Commodity Group	Fruit/wine

Project Title: Evaluating the combination of canopy leaf removal and vine devigoration on improvements to fruit and wine chemical composition

Objectives: What are the scientific objectives of the proposed project?

The primary objective of this project is to assess how fruit-zone leaf removal, a standard vineyard management practice, affects grape and wine chemical composition important for wine flavor when combined with a novel method for reducing grapevine size (i.e., vine "devigoration"). Currently, grape producers in Virginia and throughout the eastern U.S. devote considerable labor, time, and financial resources to managing grapevine growth during the growing season, as the region's humid climate and fertile soils contribute to excessive vegetative growth. High vegetative vigor is detrimental to fruit and wine quality, since vines with large canopies tend to have shaded fruit. In humid, sub-tropical regions like Virginia, fruit shading can negatively impact fruit quality by reducing grape ripeness, increasing the presence of fruit rot (e.g., botrytis bunch rot or sour rot), a major recurring problem in eastern U.S. vineyards, and altering the concentrations of fruit chemical compounds important for wine flavor. To mitigate these problems and reduce economic losses due to rot, growers implement practices throughout the season like shoot thinning, fruit zone leaf removal, and canopy hedging, all of which reduce the total size and density of the vine canopy and increase fruit exposure. However, these practices are time- and labor-intensive, especially in sub-tropical regions like Virginia where leaf removal or hedging may need to be repeated throughout the season to counter canopy regrowth.

Due to the costs of implementing these vineyard management practices, viticultural research efforts have focused on cheaper, alternative methods that achieve the same goals without incurring the same costs. Recently, mesh root bags have been studied as a method of reducing aboveground vine growth and size, primarily by restricting the growth of the total root system. This practice has been used with success in the ornamental landscaping industry and other horticultural industries, but research has only recently focused on evaluating the use of root bags for wine grapes (e.g., Cabernet Sauvignon, *Vitis vinifera*). This preliminary work shows that root bags of various sizes can successfully reduce grapevine canopy density, increase fruit

exposure, and positively affect red grape pigmentation, relative to non-root-bagged grapevines. Despite these advances, it remains unclear how vines grown in root bags respond to standard management practices like fruit zone leaf removal and if the implementation of leaf removal yields further benefits to fruit chemical composition or has other unforeseen impacts. Determining how these two practices interact to influence grape and wine quality when implemented together is an important step in determining whether the use of root bags is a justifiable lower-cost alternative to costlier canopy management practices for vineyards in humid, temperate and sub-tropical climates. Finally, given the variable environmental conditions that many grape growers face in Virginia, evaluating this practice under variable conditions (i.e., high or low rainfall seasons) would provide a robust assessment of how these practices may impact grapevine health and yield, aside from impacts on fruit and wine quality.

In summary, this project aims to develop a multi-year study that will evaluate: (1) how fruit-zone leaf removal and vine devigoration via root bagging impacts fruit and wine chemical composition; (2) whether vine devigoration and leaf removal affects long-term grapevine health and yield; and (3) if vine devigoration via root bagging can reduce operating costs compared to standard viticultural practices implemented in Virginia vineyards.

Approach: What methods will be used to accomplish the objectives?

To address the stated objectives, a randomized field experiment will be conducted for two years at Virginia Tech's Alson H. Smith Jr. Agricultural Research and Extension Center in Winchester, Virginia. The experiment will be a 2-by-2 factorial, in which both the effects of vine devigoration via root bagging and fruit zone leaf removal on measured variables will be tested both independently and together. Young (< 5 years old) Cabernet franc vines were randomly assigned to a small volume (0.015 m^3), fine-mesh root bag or no-root bag treatment prior to planting and have been maintained since planting at the AREC according to standard practices. Half of the root-bagged vines and half of the non-root-bagged vines will also receive a fruit zone leaf removal treatment applied when berry development reaches "pea-sized" stage of phenological development, as is commonly practiced in commercial vineyards. The remaining root-bagged or non-root-bagged vines will not receive any leaf removal. The requested funds will be used to help fund wages for a graduate student to conduct data collection and analysis for the objectives listed below, in addition to paying fees for chemical analysis of grapes and wines.

To assess objective 1, fruit will be harvested to measure the effects of treatments on yield components (berry weight, berry number, cluster weight, total yield), fruit chemistry parameters used as metrics of ripeness (juice total soluble solids, pH, titratable acidity, and yeast assimilable nitrogen), and the presence of rot. Additionally, subsets of fruit will be processed and vinified as microvinifications according to a standardized protocol. Non-volatile phenolic composition of wine samples and volatile composition will be assessed by an academic collaborator.

To address objective 2, various measurements will be performed throughout the growing season to determine how grapevines respond physiologically to both treatments. Stem water potential measurements will be performed periodically to assess vine water stress, since root

bagging can affect vine water uptake. Photosynthesis, an important process for plant functioning and fruit ripeness that is sensitive to stress, will also be measured. Canopy growth and density will also be monitored throughout the growing season. Lastly, woody trunk and root tissues will be sampled at the end of the growing season to capture the effects of treatments on nonstructural carbohydrates, an important energy reserve used for next season's growth.

Lastly, to address objective 3, an economic analysis will be conducted to compare the potential savings in labor costs due to vine devigoration with the costs of implementing standard leaf removal practices. Potential profits or losses due to changes in yield (i.e., lower yield or impaired fruit quality due to rot) will also be incorporated.

Justification: What impact will the proposed research have on Virginia agriculture?

The goal of this research is to advance the understanding and potential use of a novel practice that could reduce vineyard operating costs and improve fruit and wine quality. In Virginia and other states, the cost and availability of labor is a pressing concern for growers. Growers face additional challenges due to the variable environmental conditions both within and between seasons, with current projections indicating increased precipitation and warmer temperatures. These conditions favor increased vegetative growth and disease development which is likely to become costlier to manage. Thus, the development of viticultural practices that can alleviate labor costs while improving grape quality is critically important. Methods involving vine devigoration, like the mesh root bags detailed here, are potential means to achieve these goals that are under-researched. While this method may be optimal for growers who are replanting existing or new vineyard blocks, the wine industries in Virginia and the eastern U.S. are continuing to grow and this practice could be adopted by both new and veteran grape producers. Further, should this method prove useful for vineyards, it is possible that it could be adapted for use in other industries where devigoration may be desired, like the tree fruit industry.

Benefit: What are the economic benefits of the research for Virginia's farmers?

By researching a method (vine devigoration) that could reduce the operating costs of vineyards in Virginia, this research has the potential to positively impact the bottom-line of grape producers in Virginia and other mid-Atlantic and eastern states. Should this research indicate that the use of fruit zone leaf removal is not necessary in vines subjected to devigoration methods, this could reduce the labor and fuel costs otherwise incurred for implementing this practice, whether performed manually by farm workers or mechanically via automated, tractor-pulled leaf removal devices. Additionally, practices that reduce vine vigor and increase fruit exposure tend to aid in fungal and bacterial rot reduction, which may assist producers with implementing a reduced number of pesticide applications during the season. Lastly, reducing the overall percentage of annual yield lost to rot is a key priority for producers in the mid-Atlantic, and this practice may positively impact the sales of fruit at the end of the season by reducing the likelihood of rot development. In sum, this research aims to improve the long-term financial stability of vineyards and fruit-producing businesses.