The impact of rainfall and disease pressure on yields: a comparative study on organic and conventional wine grape vineyards in Stellenbosch

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Conference Presentation

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Keywords
Disease Pressure  
Yield  
Organic viticulture  
Stellenbosch

Research Question
1. Determine impact of Downy and Powdery Mildew on Yield  
2. Rainfall vs disease pressures impact on yield  
3. Disease pressure and rainfall implications on sustainability

Methods
Variance of Yield between organic and conventional production measured against regression of four disease pressure models for Downy and Powdery Mildew.

Results
Shown that rainfall has a greater influence on yield than disease pressure of Downy and Powdery Mildew. Organic production has greater yield variance than conventional grape production.
The impact of rainfall and disease pressure on yields: a comparative study on organic and conventional wine grape vineyards in Stellenbosch
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Introduction
The organic wine industry was worth US$ 7.46 billion in 2019 and is projected to reach US$ 16.65 billion by 2027 with an estimated average annual growth rate of 10.7% for the period 2020-2027 projected (TheInsightPartners.com, 2021). In contrast to the strong projected growth for organic wine, albeit from a smaller base, is conventional wine that is losing market share in the US. In addition to an overall decline in per capita consumption of alcoholic beverages, the conventional wine segment has lost more than half its market share in the last 55 years (Holmes & Anderson, 2017). Consequently, an alternative for producers to add value to their product is to switch from conventional to organic production. This will allow producers can tap into a niche market that would offer them higher returns for their produce.

With the price tag also comes a few snags. Legislation restricts the use of synthesised pesticides and herbicides, and restricts the use of copper to 4kg/ha/annum for organic wine grape production (National Agricultural Law Center, 2021). Copper as a fungicide could be applied with a total weight of 25% copper in hydrous copper sulphate. For the control of downy and powdery mildew four applications of 4kg/ha copper sulphate, equating to 4kg/ha/annum copper, is usually applied to organic vineyards for the control of Downy and powdery mildew.

Downy mildew and powdery mildew are two of the most significant grapevine diseases affecting the South African wine industry, with a significant impact on grape yields and wine quality. According to a study conducted by the Western Cape Department of Agriculture, downy mildew can cause yield losses of up to 10% in the South African wine industry (Kriel, 2022). According to a study by Halleen and Holtz (2017), powdery mildew can cause yield losses of up to 20% in the South African wine industry. With the decreased control measures for downy and powdery mildew available to organic producers, the authors deemed investigating the effect of increased disease pressure from these funguses on the yield of organic producers worth investigating. Data was collected for both organic and conventional wine grape production in Stellenbosch, South Africa.

Objectives
The study has three objectives. Firstly, the aim of the study is to determine whether the impact of these funguses, measured in terms of four disease pressure models, are significant in affecting yields for conventional and organic production systems. Secondly, disease pressure is typically lower at lower rainfall levels, but lower rainfall can also affect yields. Thus, which of disease pressure and rainfall has a greater impact on yields? Lastly, if disease pressure and rainfall are significant in affecting yields, what are the implications for producers in the context of long-term sustainability? If found to be insignificant, what could be the potential reasons be and what other variables should be considered.

Materials and methods
The average yield of conventional and certified organic producers from 2013 to 2021 in the Stellenbosch region was measured. This was used as a base and the variance of each year from this mean was calculated. The variance for each season was overlayed with four disease pressure models used in the industry to measure downy and powdery mildew pressure potential. These four models are:
• UC Davies Grape Powdery Mildew Primary infection Pressure (100-point scale)
• Mills Table Secondary Powdery mildew infection table (adapted from apples)
• Grape Downey Mildew Primary infection 10/10/24 rule
• Grape Downey Mildew Secondary infection (> 45-degree days)

Multi variate ANOVA regressions were run between the grape yield variance and the disease pressure models selected.

Results
After incorporating the data for yield and disease models into a single dataset for the analysis, it was found that the UC Davies Grape Powdery Mildew Primary infection Pressure maxed out for all days measured under Stellenbosch conditions and was therefore not included in consequent calculations. The yield variance on conventional vineyards was 14% from the average, compared to 28% for organic vineyards. Regression fit for the variance between yield
and disease pressure was 54% and 43% for the conventional and organic vineyards, respectively, but with a large significant F-value showing no statistical difference. When adding another variable, i.e. average rainfall for the seasons, into account, the regression fit went up to 73.9% and 75.2% for the conventional and organic vineyards respectively, but also showing a large significant F-value and thus no statistical significance. Removing variables with p > 0.05 did yield results. Secondary downy mildew infection and rainfall is the best indicator for yield in both the organic and conventional win grape farming in the Stellenbosch region. Statistically significant 66% and 67% regression lines for conventional and organic production, respectively, were returned.

Conclusion
Secondary downy mildew infection and rainfall is the best indicator for yield in both the organic and conventional win grape farming in the Stellenbosch region. The decreased variance in conventional farming yield indicates the advantage and importance of having a wide variety of control options in the form of fungicides to lessen production risk for the producer.

Rainfall between October and December in the South African growing season has been shown to be a significant indicator for yield even on irrigated vineyards. This would indicate that water stress management is of higher importance than disease pressure management especially for organic producers.

The increased risk of organic farmers necessitates a price premium for them to stay economically sustainable. To counteract the increased risk in for Stellenbosch organic producers, purely taking yield variance into account, an organic producer needs about 40% premium on their grape price. This price premium is over and above the 30% reduced input costs that organic farmers in South Africa have over conventional farmers.

An area that should be considered for future research is how the combined water stress and disease pressure lessens ability of vines to breakdown complex nutrients found in organic fertilisation. Dry soils lessen the effectiveness of soil micro flora that are integral to successful organic farming. This interaction could explain some of the collinearity seen in this study and help organic producers improve directing expenditure.

References


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