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Title:

Investigation of mechanized fruit zone leaf removal on yield and berry parameters in *Vitis vinifera* cv. 'Chardonnay' and 'Merlot'.

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Objectives:

(1) Analyze costs of mechanized leaf pulling vs. hand leaf pulling in a commercial Southeastern vineyard on VSP.
(2) Investigate the impact of mechanized leaf pulling on yield, cluster structure, disease incidence and berry chemistry

Justification and Description:

The grape and wine industry in the Southeast is rapidly growing. In 2015, grape and wine businesses in North Carolina alone had an impact of nearly $2 billion on the states' overall economy (Rimerman et al. 2017). That is an increase of ca. 30% compared to 2009 (Rimerman et al. 2011). Companies such as Duplin Winery, Biltmore Estates or Shelton Vineyards have a rich history in North Carolina and affect the economy of the whole Southeast. 13 American Viticulture Areas (AVAs) are established in Virginia (7), North Carolina (5, one shared with GA) and Georgia (2, one shared with NC). There are estimated to be ca. 800 vineyards and close to 200 wineries in North Carolina alone. Grape and wine businesses are often the local thriving force in the economic and educational development of rural areas in the Southeast (e.g. the establishment of the NC viticulture center at Surry Community College, Dobson NC). The Southeastern grape and wine industry contributes to an enhanced agro-tourism and to cultural diversity in both rural and urban environments.

Despite these advances, growing grapes in the Southeast remains challenging and expensive. Estimates of the operating costs to grow *V. vinifera*, French-American and interspecific hybrids range from $2,500 - $3,500 per acre per year, mostly generated by salaries and wages. This does not include one-time investments. Labor intensive tasks over a season of vineyard management include pruning, shoot thinning, leaf pulling and hand-harvest.

Mechanized solutions for some cultural tasks are developed and available for purchase (e.g. hedging and leaf-pulling devices). But high up-front investment costs, combined with open questions about reliability under Southeastern growing conditions, keep many growers from purchasing potentially cost and time saving equipment.

Fruit zone leaf removal is an important disease control and fruit quality management method (Wolf et al 1986, Hickey et al. 2018). Although mechanized fruit zone leaf removal equipment is readily available and commonly used in other grape growing regions in the U.S., vineyard operations in the Southeast use primarily manual labor to remove leaves. We hypothesize that the use of mechanized fruit zone leaf removal methods will lead to a significant reduction of costs per acre without affecting yield and/or berry quality. In this study, we aim to (1) investigate the economy of mechanized fruit zone leaf removal in direct comparison to hand fruit zone leaf removal and (2) to investigate the impact of mechanized fruit zone leaf removal on yield, berry weight, disease incidence and berry chemistry.

Eric Case, a Hendersonville native and former South Carolina tomato grower, is managing Burnshirt vineyards for almost 10 years now. In my opinion, Eric is one of the most progressive *vinifera*/hybrid vineyard managers in the state of North Carolina. Burnshirt vineyards has roughly 40 acres of *vinifera* and hybrid grapes in two locations, most of them on VSP, planted on a 6 foot spacing. In winter 2017/18, Burnshirt vineyards purchased a 19" Pellenc ® Leaf Remover, a joystick operated, touch sensitive, tractor mounted leaf remover, an investment of roughly $26,000.

In May 2018, Dr. Cain Hickey, Eric Case, Karen Blaedow and myself installed two field trials at Burnshirt vineyards with the aim to assess and eventually demonstrate the economy and yield effects of mechanized fruit zone leaf removal. One field trial was established in *V. vinifera* cv. 'Chardonnay' and one field trial in *V. vinifera* cv. 'Merlot'. The following treatments were installed in both cultivars (5 replicates each, 5 vines per replicate): (1) No Leaf Removal; (2) Mechanized Leaf Removal; (3) Standard (crew) leaf removal; (4) Leaf Removal of two basal leaves per fruitful shoot; (5) Leaf Removal of four basal leaves per fruitful shoot; (6) Leaf Removal of six basal leaves per fruitful shoot.

Following parameters were assessed in the 2019 season: (1) time to remove leaves (mechanical and crew) (2) fruit zone composition (3) cluster disease incidence at day of harvest (4) yield, average cluster weight (5) average berry weight (6) basic berry chemistry (SS, TA, VA). A meeting with Eric Case is planned for Dec. 13 and 14 2019 to assess the economic impact of the mechanical leaf puller per acre of operation.

Results:

Mechanical and leaf removal through the crew had no significant effect on yield, cluster number or berry size in Merlot or Chardonnay, compared to all other treatments. However, our results show that no leaf removal as well as the removal of only two leaves (opposite of a cluster) will significantly increase disease incidence and severity in Chardonnay (Table 1) and increase TA in Merlot (Table 2). We estimate that on a 30 acre operation, the investment of a mechanical leaf remover can be profitable in the third year after purchase (see https://www.youtube.com/watch?v=4DPvb3cBlQk). However, detailed budget reviews will be done Dec. 13 and 14 2019 by PI Hoffmann and the vineyard manager Eric Case.

Conclusions:

We conclude that depending on topography of the vineyard, a mechanical leaf puller can lead to substantial savings in a medium-large seized vineyard operation. We further conclude that post-bloom fruit-zone leaf removal leads to decreased disease incidences of bunch rots and to more favorable berry chemistry. Currently PIs Hickey and Hoffmann are preparing to disseminate those data through extension publications and are preparing a research paper in 2020.

Literature:

Hickey, C.C., White, R.S., Eason, N., MacAllister, C., Vogel, A., and P. Brannen. 2018. The effect of leaf removal timing and magnitude on sour rot and Botrytis bunch rot in Georgia-grown Chardonnay. APS Plant Disease Management Report 12:PF014.

Rimerman, F. and Co.LLP. 2011: The economic impact of wine and wine grapes on the state of North Carolina – 2009. 18pp.

Rimerman, F. and Co.LLP. 2017: The economic impact of wine and wine grapes on the state of North Carolina – 2015. 18pp.

Wolf, T.K., R.M. Pool, and L.R. Mattick. 1986. Responses of young Chardonnay grapevines to shoot tipping, etephon, and basal leaf removal. Am. J. Enol. Vitic. 37: 263-268

Figure 1: Disease in Chardonnay, one panel of 6-leaf removal treatment, automated leaf remover used in the trial

Video 1: Short Youtube video to demonstrate the automated leaf remover

Table 1. Disease severity and incidence in Chardonnay**.**

Treatment	***Disease Severity (%)***	***Disease Incidence (%)***
Mechanical	0.688	21.2
Control	**2.94**	**36**
4 leaf removal	0.538	18.8
6 leaf removal	1.108	21.6

Table 2. Brix, pH and TA of Merlot

Treatment	**Brix**	**pH**	**TA (g/L)**
2 Leaf removal	17.46	3.622	**4.138**
4 Leaf removal	18.56	3.722	3.788
6 Leaf removal	18.62	3.766	3.634
Crew leaf removal	18.2	3.734	3.722
Mechanical	18.02	3.736	3.824
Control	18.02	3.586	**4.154**