SRSFC Project 2022-R-01 Report: Evaluation of Extenday® Reflective Groundcover for Sour Rot Management in Chardonel and Cabernet Sauvignon Wine Grapes in the Southeastern US

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Abstract:
Grape sour rot is a pervasive disease complex that causes late-season cluster decay. Fueled by acetobacter bacteria, wild yeast and opportunistic fungi, infection severity is exacerbated when drosophilids spread the causal organisms from cluster to cluster. Despite implementing recommended management protocols, many producers continue to incur high losses from sour rot. Effects of reflective groundcovers on pest populations and pathogens in southeastern wine grape production is largely unknown, but ultraviolet radiation (250-400 nm) and other light spectra have been documented to impact pathogens and insects in other cropping systems. Field studies were conducted on 'Chardonel' (n=40) and 'Cabernet Sauvignon' (n=32) to investigate the effects of Extenday® DayBright groundcover on sour rot development and fruit quality. Treatments were deployed at the onset of veraison and remained until commercial harvest for both cultivars. At both sites, Extenday® reflected more ultraviolet radiation into the canopy than sod-covered row middles (untreated control) ($P \leq 0.05$). Other environmental parameters varied by location/cultivar. In 'Chardonel', the average temperature and dew point in the canopy were lower in Extenday® plots, while relative humidity was higher compared to the control. 'Cabernet Sauvignon' showed differing trends, with Extenday® plots having a higher maximum temperature and average relative humidity in the canopy. Both sites had less *Drosophila* spp. trapped in Extenday® plots, and 'Chardonel' had reduced sour rot severity in vines treated with Extenday®. Fruit quality analyses of berry samples (n=80) revealed 'Chardonel' had higher soluble solids, a higher pH, and lower titratable acidity in fruit collected from Extenday® plots. Berry samples collected from 'Cabernet Sauvignon' showed fruit from Extenday® plots had lower titratable acidity than fruit in the control plots. These results suggest that the reflective properties of Extenday® may influence fruit maturity and may also disrupt the vineyard conditions that harbor drosophilids and favor sour rot development.

Objective:
Determine the effects of Extenday® DayBright groundcover compared to sod row middles (untreated control) on *Drosophila* spp. populations, sour rot, and fruit quality.

Description and Justification:
Wine grapes in Georgia primarily consist of European (*Vitis vinifera*) and interspecific hybrid varieties. Aside from damaging spring frosts and vine mortality due to Pierce's disease, primary drivers for economic loss are aggressive fungal diseases. The subtropical southeastern climate provides ideal conditions for development of sour rot (Fig. 1). Over the past several years the grape sour rot complex has received increased recognition by stakeholders and researchers. Fueled by *acetobacter* bacteria and opportunistic fungi occupying a grape's exterior and interior, infection severity is exacerbated when drosophilids inadvertently spread the causal organisms from cluster to cluster (Blaauw et al., 2018). Invasion is suspected to occur at the point at which a grape berry is injured. These factors coupled with the favorable environmental conditions in the southeastern US lead to eventual outbreaks of sour rot when wine grapes begin to ripen. Thin-skinned, tight-clustered varieties are thought to be at higher risk relative to thick-skinned, loose-clustered cultivars. Symptoms are most commonly observed once berries reach 15 Brix. Thus, management programs tend to be initiated at the onset of veraison and involve a

combination of chemical and cultural control tactics. Fruit zone leaf removal is an important canopy management practice used to manage crop yield, fruit quality, and bunch rots. While recent research has indicated the practice may lend inconsistent results for sour rot management in high humidity regions (Hickey et al. 2019), improved sour rot control has been achieved when fruit zone leaf removal is performed in conjunction with weekly antimicrobial and insecticidal sprays at 15 Brix (Blaauw et al., 2018). This management paradigm is difficult for growers to consistently execute, as leaf pulling in addition to weekly pesticide applications is expensive, labor intensive, and time sensitive. Another motivator for finding alternative management strategies for grape sour rot is the looming threat of Drosophila resistance to commonly used insecticides (Sun et al., 2019).

When faced with severe outbreaks, growers can expect significant economic loss through diminished fruit quality and reduced yields. While the effects of reflective groundcovers on pest populations and pathogen development are largely unknown in the southeastern US, impacts of UV and other light spectra have been found to influence pathogens and insects (Comeau et al., 2012; Janisiewicz et al., 2016). Furthermore, the UV reflective properties of commercially available reflective groundcovers can affect multiple plant growth and development processes. In apple, intensity and distribution of red pigment (anthocyanin) was enhanced with the use of Extenday® (Iglesias and Alegre, 2009). Reflective groundcovers with increased PAR and UV irradiance have also been shown to intensify skin color and phenolic compounds in wine grapes (de Palma et al., 2020). Extenday® was selected for this research because it not only reflects photosynthetically active radiation (PAR; 400-700 nm) but also ultraviolet radiation (UV; 250-400 nm). The vineyard environment can be dramatically altered by the singular input of reflective groundcover, as canopy light environment, relative humidity, and temperature are directly influenced. Given this change in the vineyard microclimate, insect populations and pathogen development may be influenced.

Procedures:
A randomized complete block design was used to investigate the effects of Extenday® DayBright groundcover. The 'Chardonel' trial (Fig. 2) had five replications and the 'Cabernet Sauvignon' trial (Fig. 3) had four replications per treatment. Untreated plots (sod row middles) were included for comparison and all plots were buffered to minimize edge effects. Four vines served as an experimental unit for each treatment within each block. Extenday® was placed adjacent to plots on two rows and covered 80% of the vineyard row middle (Fig. 4). Extenday® panels were secured using a proprietary mounting system per manufacturer recommendations. Extenday® was deployed at the onset of grape ripening (veraison) and remained until commercial harvest at both sites. JMP Pro 15 was used for data analysis, and Tukey's HSD was utilized for treatment means separation.

Environmental factors concerning canopy microclimate (temperature, relative humidity, and dew point) were measured at 15-minute intervals with WatchDog B102 Button Loggers (Spectrum Technologies, Inc., Aurora, IL). Dataloggers were placed in three replicates in the 'Chardonel' trial and four replicates in the 'Cabernet Sauvignon' trial. At both sites, incident and reflected ultraviolet radiation (250-400 nm) and photosynthetically active radiation (PAR; 400-700 nm) were quantified in four vines per plot. PAR and UV measurements occurred proximal to solar noon on a uniformly cloud-free and fully cloudy day. Measurements occurred on the east and west sides of the vines at the 'Chardonel' trial, and north and south sides of the vines at the 'Cabernet Sauvignon' trial. Incident and reflected PAR measurements were quantified using a ceptometer (AccuPAR PAR/LAI Ceptometer Model LP-80; Decagon Devices Inc., Pullman, WA). To quantify incidental PAR (ambient light), the instrument was held in a horizontal position and oriented toward the sun. PAR reflectance was quantified by inverting the sensor (facing the ground). Similarly, incident and reflected UV radiation were measured using a UV light meter (Field Scout™ Model 3414F Ultraviolet Light Meter; Spectrum Technologies, Inc., Aurora, IL) following the same methods used for measuring PAR.

Drosophila populations were passively monitored using yellow sticky cards suspended in the fruiting zone of two vines per experimental unit. Cards were replaced on a weekly basis until commercial harvest at both sites. Soluble solids, titratable acidity and pH analyses were conducted to compare groundcover impacts on fruit quality and development. Disease ratings for 'Chardonel' were conducted at commercial harvest on August 16, 2022. Leaves were collected across each experimental unit (4 vines) and assessed for downy mildew incidence (% leaves infected) and severity (% leaf area with downy mildew). Fruit clusters were rated for sour rot incidence (% of clusters infected) and severity (% cluster covered with rot). Similarly, on September 14, leaf and fruit cluster disease ratings were conducted for the 'Cabernet Sauvignon' trial following the same rating procedures described for the 'Chardonel' trial.

Results and Discussion:
The 'Chardonel' trial was conducted at Engelheim Vineyards, and the 'Cabernet Sauvignon' trial was conducted at Cartecay Vineyards. For both sites, Extenday® was deployed at the onset of veraison, the presumed timeframe at which drosophila damage may initially occur and subsequent sour rot infections are suspected to initiate. Based on these criteria, the 'Chardonel' trial was initiated on 14 July, and the 'Cabernet Sauvignon' trail was initiated on 23 July.

Treatment influences on temperature, relative humidity, and dew point varied by location/cultivar. Approximately two weeks prior to commercial harvest of the Chardonel trial (3 Aug-16 Aug), the average temperature and dew point were significantly lower in Extenday plots, while relative humidity was significantly higher compared to control plots (Table 1). Potential reasons for the lower temperature and dew point in the Extenday plots include the possibility of the groundcover serving as a barrier preventing radiative heat from the earth's surface from rising in to the lower vine canopy in the evening hours. Having said that, trends observed in the 'Cabernet Sauvignon' site showed differing results. Other than a higher maximum temperature in Extenday® plots, no other differences in temperature, relative humidity, and dew point were quantified (Table 2).

Regarding incident and reflected UV radiation, at both sites the plots treated with Extenday had significantly higher levels of UV reflectance than control plots on both fully cloudy (Table 3) and fully cloud-free (Table 4) days; however, there was no difference observed between treatments for incident UV radiation at either site. The PAR data has not yet been analyzed, but based on PAR measurements quantified on Extenday in previous apple work, the incident and reflected readings followed suit with those of the UV radiation measurements. As referenced above, previous research has indicated that UV and other light spectra may influence pathogens and pest populations. Based on the data collected from these trials, we believe Extenday may have influenced the behavior of both drosophilids and leafhoppers. Both sites had a significant reduction in the overall number of *Drosophila* spp. trapped in Extenday plots (Table 5). Additionally, at the 'Chardonel' site, there was a reduction in leafhopper/sharpshooter populations.

Downy mildew and sour rot disease ratings for the 'Chardonel' trial were conducted at commercial harvest on August 16, 2022. Leaves (n=50) were collected across each experimental unit (n=4) and assessed for downy mildew incidence (% leaves infected) and severity (% leaf area with downy mildew). Fruit clusters (n=50) were also rated for sour rot incidence (% of clusters infected) and severity (% of fruit cluster with sour rot). 'Chardonel' had no differences in downy mildew incidence and severity on leaves; however, there was a reduction in sour rot severity on fruit clusters from vines treated with Extenday® (Table 6). Reduced populations of drosophilids may have contributed to the decreased sour rot severity on vines treated with Extenday at the 'Chardonel' site; however, there was no significant sour rot incidence observed in 'Cabernet Sauvignon', so no data was collected from that location for sour rot. Rather, total rot ratings were conducted due to overwhelming disease pressure caused by a reduced spay

program from the grower collaborator. Furthermore, due to poor vineyard management throughout the growing season, an extreme amount of downy mildew and various fruit rots were present during the time period when disease ratings were conducted. Due to the extreme disease pressure, no differences were observed between treatments regarding downy mildew on leaves or fruit rots in 'Cabernet Sauvignon'.

Regarding fruit composition, at commercial harvest 'Chardonel' berry samples (n=80) in Extenday® plots exhibited a significantly higher concentration of soluble solids, a higher pH, and a lower titratable acidity (Table 7). These results suggest that the reflective properties of Extenday may influence fruit maturity. No differences were observed between treatments regarding cluster number, berry weight, and total vine yields. Due to widespread foliar and fruit-related diseases, harvest data, such as cluster number and vine yield could not be calculated in 'Cabernet Sauvignon'. However, berry samples were collected on Sep Sep 29 (date of commercial harvest) for analysis of soluble solids, titratable acidity, and pH. Due to widespread disease in this vineyard, fruits were harvested prior to full physiological maturity. Nevertheless, berries in Extenday® plots were found to have a lower titratable acidity than fruit in the control plots. Potential reasons why the 'Cabernet Sauvignon' berries in Extenday plots did not reflect the advanced maturity that was observed in the 'Chardonel' trial could be that extensive fruit rot damage and the fact that the fruit were harvest prior to full maturity.

Impact:

Grape sour rot is an economically devastating disease complex that is challenging to manage. In years when rains extend into harvest, yield and fruit quality losses can be significant. In 2019, a survey was conducted by Dr. Cain Hickey (previous UGA Extension Viticulture Specialist) to identify the pervasiveness of sour rot in southeastern wine grape producing regions. Survey respondent indicated that despite having implemented current sour rot management strategies, 50% of growers in GA, NC, and VA described their problems with sour rot as either "moderate" or "severe". Thin-skinned, white-berried *V. vinifera* and hybrid cultivars were cited as particularly susceptible. 'Chardonel', an interspecific hybrid, ('Chardonnay' x 'Seyval Blanc') was selected because it was cited as a sour rot prone cultivar in this survey. Furthermore, based on survey responses, sour rot affected 38% of the acreage in Georgia, 25% in North Carolina, and 20% in Virginia. Many growers are following recommended management practices but many are still accruing unacceptable losses to this disease. Thus, this research team is motivated to continue seeking alternative, practical approaches to manage this disease and improve fruit quality. These first-year results suggest that the reflective properties of Extenday® may influence fruit maturity and, as with leaf pulling, may also disrupt the vineyard conditions that favor sour rot development. In both cultivars, Extenday increased UV radiation reflectance and decreased *Drosophila* spp. populations. The 'Chardonel' trial also had decreased sour rot severity and increased fruit maturity factors. In 2023, we intend to repeat what was done this year, but we intend to add fruit zone leaf removal as a factor (split plot). We will also take a closer look at the environmental conditions in the vineyard microclimate (within the vines and below the groundcover).

Table 1. Effects of Extenday® on the canopy microclimate of 'Chardonel' wine grapes from 3 August to 16 August, 2022.

	Temperature (°F)			Relative Humidity (%)			Dew Point (°F)		
Treatment	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Control	92.3 a	68.1 a	78.8 a	99.9 a	56.8 a	81.8 a	77.5 a	67.9 a	72.1 a
Extenday®	93.7 a	65.7 b	75.6 b	100.0 a	54.5 a	87.7 b	78.3 a	65.6 b	71.0 b

Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Table 2. Effects of Extenday® on the canopy microclimate of 'Cabernet Sauvignon' wine grapes from 1 Sep to 15 Sep, 2022.

	Temperature (°F)			Relative Humidity (%)			Dew Point (°F)		
Treatment	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Control	90.1 a	61.0 a	70.9 a	100.0 a	53.7 a	88.0 a	74.0 a	60.9 a	66.2 a
Extenday®	93.3 b	60.6 a	71.1 a	100.0 a	49.3 a	86.6 a	73.4 a	60.4 b	65.8 a

Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Table 3. Interception and reflectance of ultraviolet radiation (250-400 nm) on Extenday® DayBright groundcover applied to 'Chardonel' and 'Cabernet Sauvignon' on a uniformly cloudy day.

	Chardonel 13 Aug. 2022		Cabernet Sauvignon 9 Sept. 2022	
Treatment	UV Radiation Interception	UV Radiation Reflectance	UV Radiation Interception	UV Radiation Reflectance
Untreated control	50.2 a*	0.8 a	52.8 a	0.8 a
Extenday®	53.9 b	13.2 b	56.5 b	11.7 b

*Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Table 4. Interception and reflectance of ultraviolet radiation (250-400 nm) on Extenday® DayBright groundcover applied to 'Cabernet Sauvignon' on a uniformly cloud-free day.

	Chardonel 14 Aug. 2022		Cabernet Sauvignon 29 Aug. 2022	
Treatment	UV Radiation Interception	UV Radiation Reflectance	UV Radiation Interception	UV Radiation Reflectance
Untreated control	107.0 a*	1.2 a	152.6 a	1.8 a
Extenday®	110.8 a	21.2 b	151.7 a	22.7 b

*Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Table 5. Effects of Extenday® DayBright groundcover on *Drosophila* and leafhopper/sharpshooter populations in 'Chardonel' and 'Cabernet Sauvignon' wine grapes.

	Chardonel		Cabernet Sauvignon	
Treatment	*Drosophila* spp.	Leafhopper/ Sharpshooter	*Drosophila* spp.	Leafhopper/ Sharpshooter
Untreated control	1.4 a*	1.4 a	2.1 a	2.0 a
Extenday®	0.0 b	0.2 b	0.3 b	1.1 a

*Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Table 6. Effects of Extenday® DayBright groundcover on sour rot and downy mildew incidence and severity on 'Chardonel' wine grape.

	Sour rot**		Downy Mildew**	
Treatment	Incidence	Severity	Incidence	Severity
Untreated control	43.2 a*	6.6 a	14.4 a	2.0 a
Extenday®	22.0 a	2.3 b	13.6 a	1.0 a

*Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).
**Fruit Sour rot and downy mildew incidence (% cluster/leaf infected) and severity (% cluster/leaf area infected) were calculated from 50 leaves and 50 fruit clusters per experimental unit (n=4).

Table 7. Effects of Extenday® DayBright groundcover on brix, titratable acidity, and pH on 'Chardonel' and 'Cabernet Sauvignon' wine grapes.

	Chardonel 17 Aug			Cabernet Sauvignon 16 Sep			Cabernet Sauvignon 30 Sep		
Treatment	SS	TA	pH	SS	TA	pH	SS	TA	pH
Control	18.5 a	10.9 a	3.0 a	16.08 a	8.65 a	3.35 a	16.8 a	8.1 a	3.4 a
Extenday®	20.0 b	9.6 b	3.1 b	15.91 a	9.23 b	3.51 a	16.4 a	7.1 b	3.4 a

Means following the same letter are not significantly different from one another when using Tukey's HSD ($P \leq 0.05$).

Figure 1. Symptoms of sour rot on 'Chardonel'. Sour rot is caused by a disease complex that includes yeast, acetic acid bacteria (both already present in and on the grapes), opportunistic fungi, Drosophila fruit flies, and wounds.

Figure 2. Extenday® DayBright groundcover was deployed at the 'Chardonel' site at the onset of veraison and remained until commercial harvest on Aug. 16. Rows were arranged in and east-west orientation.

Figure 3. Extenday® DayBright groundcover was deployed at the 'Cabernet Sauvignon' site at the onset of veraison and remained until commercial harvest on Sept. 29. Rows were arranged in and north-south orientation.

Figure 4. Extenday® DayBright groundcover panels covered 80% of the vineyard row middle and were fastened into place using the manufacturer's recommended mounting system.

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