Assessment of sunburn damage in Chardonnay grapes in relation to leaf removal timing

J.M. Gambetta1, V. Romat1, B. Holzapfel1, 2, L.M. Schmidtke1
1National Wine and Grape Industry Centre, Charles Sturt University, Wagga Wagga, NSW 2650, Australia, 2New South Wales Department of Primary Industries, Wagga Wagga, Australia

Context and purpose of the study
Sunburn damage commonly appears as browning of the berry surface when these are directly exposed to sunlight in combination with high temperatures and ultraviolet radiation. Factors such as variety, berry developmental stage, ambient temperature, water availability and viticultural practices (i.e. defoliation) modulate the intensity of symptoms. Leaf removal is a common practice in cool viticultural areas to reduce disease pressure. However, overexposure of bunches can lead to a higher degree of sunburn. Previous research indicates that if performed before véraison, defoliation leads to an early accumulation of photoprotective compounds such as the flavonoids and the carotenoids which would protect the berry from UV damage and reduce the intensity of sunburn but evidence is lacking. The aim of this study was to evaluate the effect of leaf removal timing on the incidence of sunburn as well as on the concentration of photoprotective compounds.

Materials and Methods
Trials were conducted during the 2018-19 vintage in two Chardonnay vineyards located at two altitudes (612 masl, S1 and 884 masl, S2) in the Orange region (NSW, Australia). Treatments included a control (T1, no defoliation), early defoliation (T2, leaves removed at the end of flowering) and late defoliation (T3, leaves removed at véraison). Early leaf removal was performed on 6/12/18 at both sites, and late leaf removal on 8/1/19 at S2, and 23/1/19 at S1. All leaves and lateral shoot were removed in the fruit zone (45 cm. above the cordon) on the east side of the canopy, which was maintained exposed during the remainder of the season. Harvest occurred on 4/2/19 at S2 and 4/3/19 at S1. Berry samples were collected every two weeks from véraison onwards for compositional analyses (TSS, TA, pH, YAN, flavonoids, carotenoids and chlorophyll). Fifteen bunches per treatment, repetition and vineyard (n = 270) were collected at harvest and photographed using a blue background for image analysis using RotBot (Hill et al., 2014) and evaluation of sunburn level.

Results

Sunburn Incidence
• A higher percentage of berries burned to a higher intensity when leaf removal was performed at véraison rather than earlier, at the end of flowering.
• Sunburn incidence was higher at S2 due to extremely high temperatures during ripening.

Berry weight, pH, TA, TSS, YAN and yield
• Despite the removal of leaves, there were no significant differences in berry weight, pH, TA, TSS and YAN between treatments within a same vineyard.
• Regardless of when it was conducted, leaf removal, did not significantly affect bunch weight or yield at harvest. The remaining leaf area was sufficient to ripen the fruit to the desired 21-22 °Brix.

Flavonoid content
• Early defoliation caused an early rise in the concentration of flavonoids so that by véraison, T2 contained 2-2.5 times of all flavonoids than T1 or T3 berries.
• Differences were observed between the behaviour of quercetin-3-glucoside (Q3G) and the other flavonoids analysed. Q3G quickly increased in T3 after leaf removal, up to levels similar to those in T2, this trend was not observed in the other flavonoids.
• Despite leaf removal, the concentration of isorhamnetin-3-glucoside (3G), myricetin-3-glucoside (M3G), and larcitrin-3-glucoside (L3G) remained low in T3 until the end of the season.

Carotenoid and chlorophyll content
• Concentration of all carotenoids (except zeaxanthin) and chlorophylls peaked at véraison.
• Concentration increased significantly in T2 following early leaf removal. Late leaf removal, did not have this same effect. The only carotenoid that increased in T3 following defoliation was zeaxanthin, confirming that all photoprotective compounds were more responsive to light in the early stages of berry development and that acclimation to light stress occurs early on.
• Higher amounts of zeaxanthin compound were detected in T2 and T3 than in T1 in both vineyards. The concentration of this compound was higher in T2 than in T1 and T3 at the beginning of the season, following early leaf removal. The concentration of zeaxanthin in T3 increased dramatically after leaf removal at véraison.
• At harvest, T2 and T3 berries from S2 contained significantly lower concentrations of chlorophyll a and b than those from S1, and also exhibited the highest levels of sunburn.

Conclusions
• Sunburn damage was lower in berries that were defoliated earlier in the season than in those that were exposed later. Non-defoliated berries had the least sunburn damage. Sunburn damage was exacerbated in S1 and S2 by the extremely high temperatures observed during January 2019.
• All photoprotective compounds analysed (flavonoids, carotenoids and chlorophylls) were more responsive to light in the early stages of berry development, and their concentrations increased rapidly after early leaf removal. The earlier accumulation of these compounds appears to have protected T2 berries from greater sunburn damage. By véraison, berries loose the capacity to synthesise most of these compounds, and when leaf removal is performed at this stage, the berry lacks the capacity to acclimate to the new light high conditions by producing more of these photoprotective compounds.