UV radiation in New Zealand: implications for grape quality

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Abstract. Here we report preliminary findings from current research on the effects of ultraviolet (UV) radiation on grape chemistry under New Zealand field conditions. Treatments were applied by shielding the fruit zone of Sauvignon Blanc vines from solar UV radiation with plastic filters that had differential transmission spectra. We hypothesised that the differential application of UV treatments will affect grape quality. High performance liquid chromatography was used to examine UV effects on grape quality characteristics. The results showed a number of UV-induced effects in grape berries. While grape morphology was affected mainly by UV-B, levels of UV-absorbing compounds in grape skins increased with decreasing UV wavelengths. This has implications for vineyard management and wine quality.

Introduction

Compared to similar temperate latitudes in the northern hemisphere, levels of UV radiation in New Zealand are relatively high. This is due to several natural and anthropogenic factors and affects the UV-A (315-400 nm) and particularly the UV-B (290-315 nm) region of the solar spectrum (Seckmeyer *et al.*, 2008). While UV-B, and to a lesser degree UV-A, have been described as stress factors for plants, these wavelengths can also fulfil important regulatory roles in plant function (Ulm & Nagy, 2005).

Due to their sessile nature, plants cannot avoid UV radiation and therefore have evolved a number of adaptive mechanisms to protect themselves against negative stress effects. Examples of such adaptations include thicker epidermal cell layers and accumulation of sunscreens to absorb UV (Hofmann *et al.*, 2000). A key group of UV-absorbing plant pigments are the flavonoids. These compounds are frequently found in epidermal cell layers at the plant surface and are also known to act as antioxidants that can affect important wine quality characteristics (El Gharras, 2009; Rice Evans *et al.*, 1997).

Little is known about the effects of UV radiation on grape vine cultivars growing in New Zealand, and on the resulting grape juice and wines. The aim of this study was therefore to examine responses to UV radiation in New Zealand-grown grapes.

Experimental

Plants of the grapevine (*Vitis vinifera* L.) cultivar Sauvignon Blanc were investigated during the 2007/2008 growing season in a research vineyard at Lincoln University, Canterbury, New Zealand (Figure 1).

Figure 1. UV experimentation in the research vineyard at Lincoln University, Canterbury.

Using plastic filters with differential transmission of UV radiation, the fruit zone of Sauvignon Blanc vines was exposed to three solar UV treatments: (i) to all UV wavelengths, providing near-ambient UV levels (‘UV-A & UV-B’), or (ii) only to UV-A (‘UV-A’), or (iii) it was shielded from most solar UV (‘Lo UV’) (Figure 2).

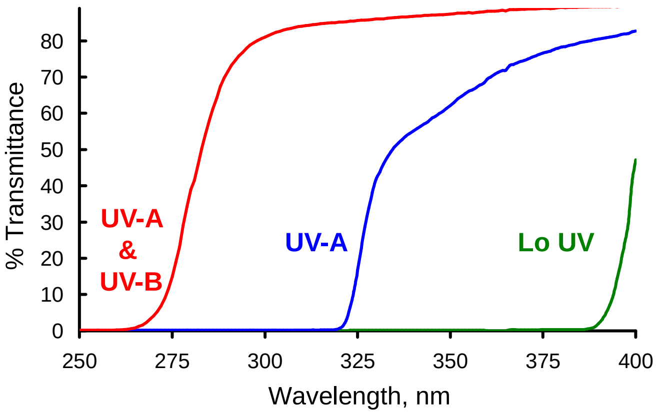

Figure 2. UV transmittance of the filters used in the study.

A special emphasis was placed on grape berry biochemistry. High performance liquid chromatography (HPLC) was used to examine UV effects on the accumulation of total UV-absorbing compounds, including flavonoids in methanolic grape skin extracts (Hofmann *et al.*, 2000). Grape juice was also analysed for sugar and amino acid levels and the berries were examined pre-harvest for possible signs of morphological damage.

Results and Discussion

The morphological observations in grapes revealed wavelength-dependent effects of ambient New Zealand UV radiation. Grape skin damage, in the form of 'brown sunburn spotting', was not present in plants grown under filters that only transmitted UV-A or no UV radiation (Figure 3A), but became apparent when plants received UV-B (Figure 3B). This specificity within the UV spectrum for symptoms of morphological damage underlines the role of UV-B as *the* sunburning waveband for grapes and other horticultural crops (Schrader *et al.*, 2003).

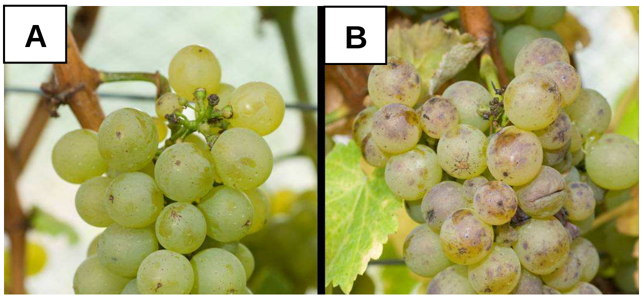

Figure 3. Grape berries grown under filters that exclude (A) and transmit UV-B (B).

The accumulation of protective UV-absorbing compounds, including flavonoids in grape skins increased with decreasing UV wavelengths. Compared to the 'Lo UV' treatment, the accumulation of UV-absorbing pigmentation was double in grape skins grown under UV-A-transmitting filters and triple when grape berries were exposed to the full solar UV spectrum (Figure 4). UV-absorbing compounds such as flavonoids have high absorbance in the UV-A and UV-B region of the solar spectrum and also can serve as antioxidants that scavenge free radicals induced by UV-B (Rice Evans *et al.*, 1997).

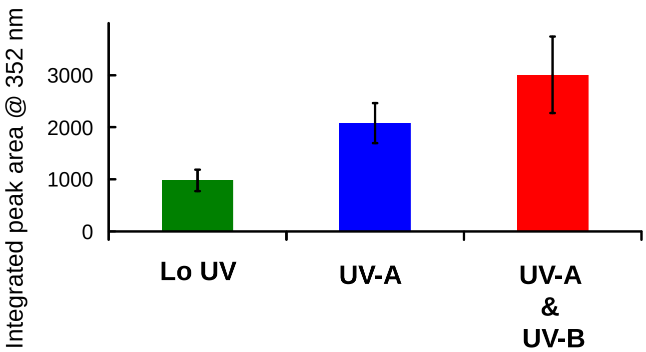

Figure 4. Total HPLC peak areas of UV-absorbing compounds in skin extracts from grape berries grown under three UV filter treatments. Error bars are ± SE.

Preliminary results also indicate that sugar levels are increased by UV-B radiation. Further experiments are in progress to confirm this finding.

Conclusions

These studies show UV-induced effects on important grape quality parameters. UV-induced increases in UV-absorbance and antioxidant potential of the grape tissue will also affect quality characteristics in grape juice and wine and this will become a focus for future studies. The knowledge of specific UV effects on grape berry quality needs to be taken into account in the management of grapevine canopies, e.g. in regard to timing and intensity of vine leaf removal during the grape berry ripening process.

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