Shedding light on netting

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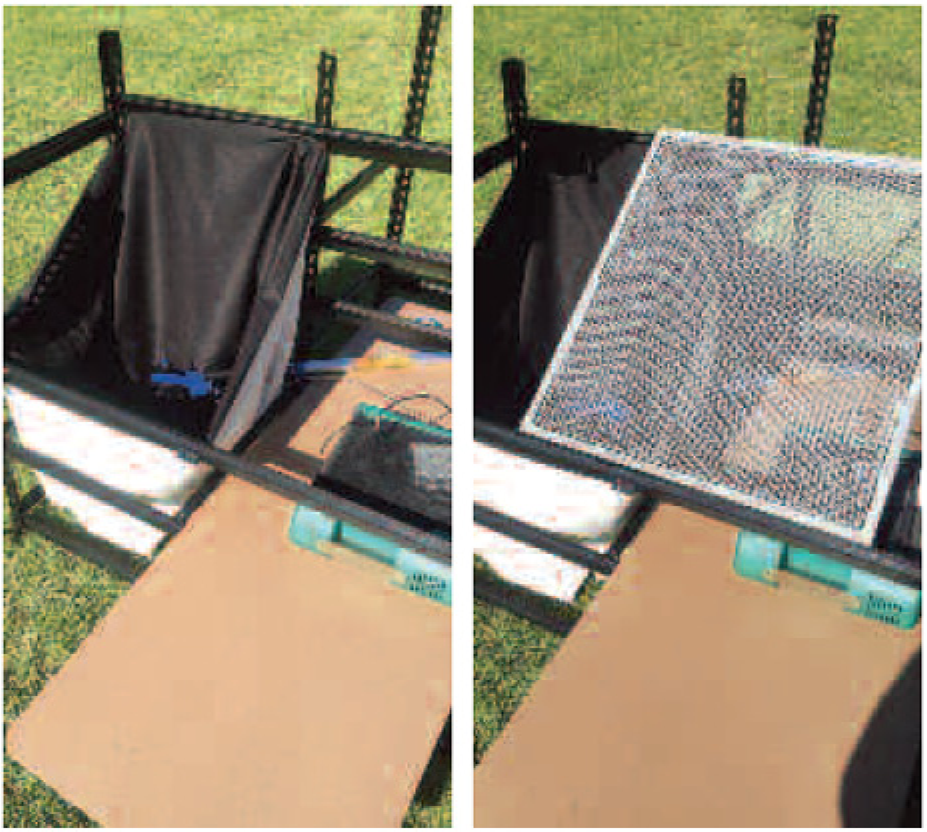
Netting intercepts solar radiation, reducing the amount of energy reaching fruit and hence lowering the risk of sunburn and colour bleaching of fruit. However, netting also lowers radiationthat is needed for photosynthesis and colour development. In this article we present some preliminary data on the effects of netting on some important wavelengths of light.

There are many types of netting available for apple and pear growers to use for hail protection, reducing sun damage and excluding birds and bats. Netting weave density and colour and the supporting structure need to be considered before installation.

Netting weave density basically determines how much light is transmitted. Light hitting the netting weave is either reflected or absorbed and this will largely depend on the colour of the netting. The wavelength of light that is reflected will be influenced and this can affect leaf photosynthesis, fruit colour development and fruit sunburn. Similarly, the angle of the netting in relation to the position of the sun will influence how much light is transmitted and could also affect the wavelength.

In the research presented here, we measured solar radiation transmitted through several commonly used nets.



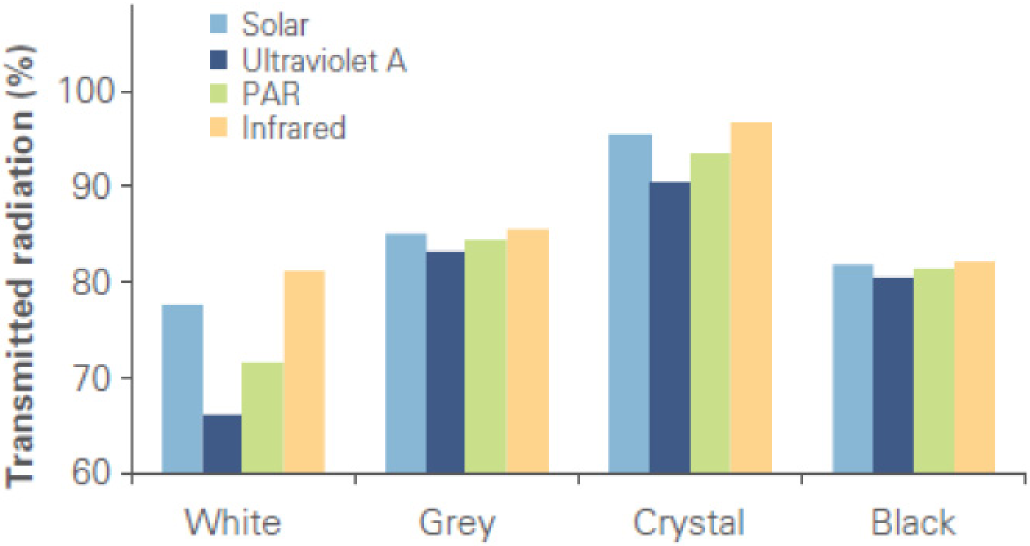
The multi-spectral radiometer (blue sensor in left photo) was enclosed in a black curtain to reduce reflected radiation. The radiometer was positioned to look upwards. Netting was fixed to an aluminium fly screen frame (right) and positioned above the radiometer at various angles to measure transmitted radiation.

Testing net differences

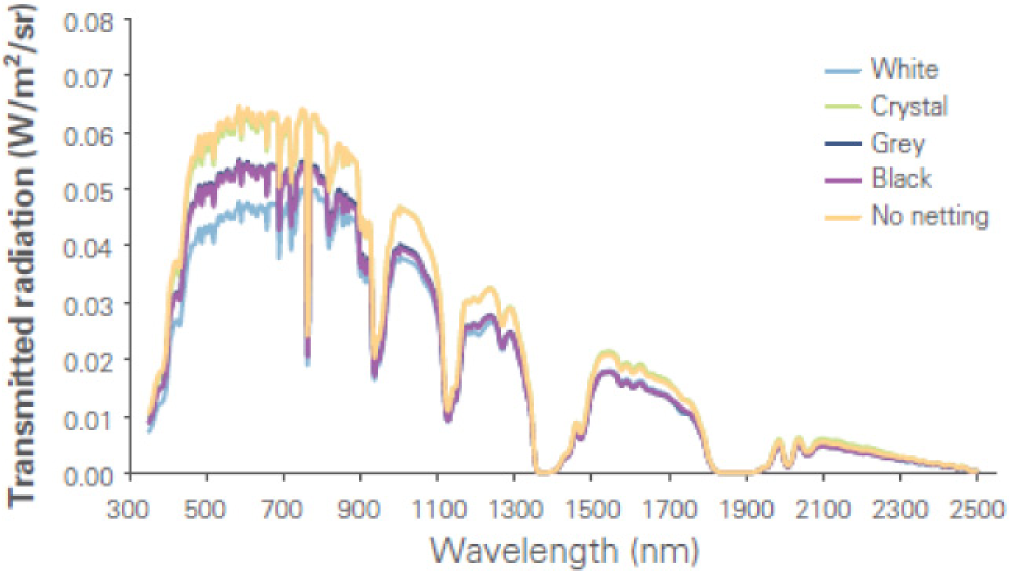
We tested four netting types: a white HDPE knitted net (12mm Qnet, NetPro, Stanthorpe, Queensland) and black, grey and crystal HDPE extruded nets (Frustar, Weiz, Austria). All three extruded nettings had the same fibre diameter and density. We fitted the netting to a flyscreen frame and positioned it on a metal support that allowed the netting angle to be adjusted to 0, 17 and 34 degrees from the horizontal and facing north.

These positions simulated solar incident angles of 72, 55 and 38 degrees. By hanging a black curtain around the spectrometer we minimised reflected radiation. To measure solar radiation, we used a multi-spectral radiometer (FieldSpec4, ASD Inc., Boulder, Colorado, United States). This instrument measures radiation in 2nm increments from 350nm to 2500nm. As such, wavebands corresponding to solar radiation (350–2500nm), ultraviolet A radiation (350–400nm), photosynthetically active radiation (400–700nm) and infrared radiation (700–2500nm) were extracted.

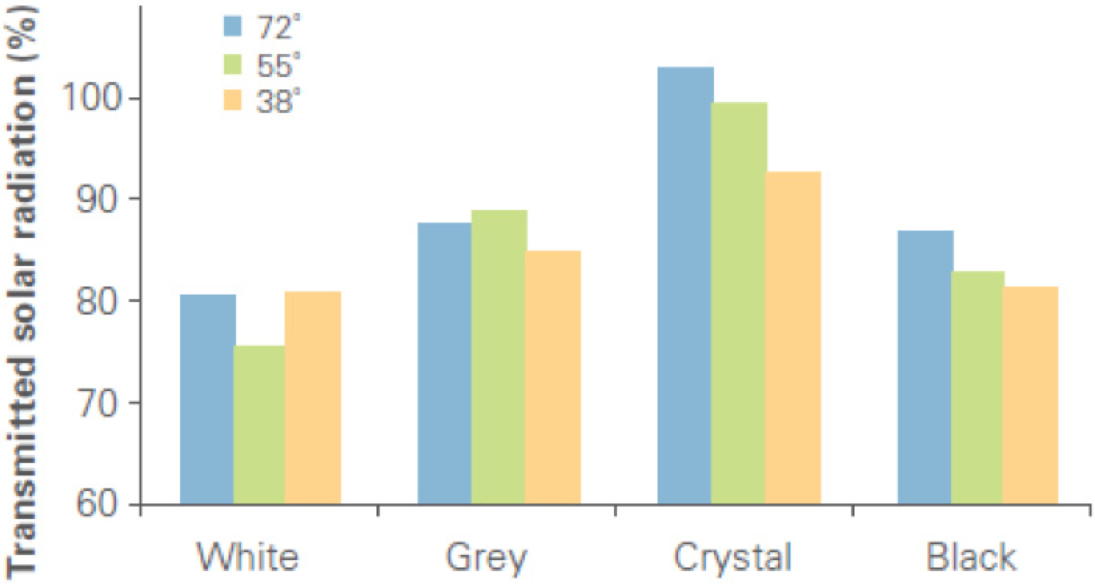
The spectrometer remained stationary below the netting while the netting was moved laterally after each spot measurement to account for any spatial variation in the netting transmission properties. We took measurements on a clear-sky day. Solar position, netting angle to the horizontal and frame orientation were used to calculate the incident solar angle.



Percent transmitted solar radiation (blue), ultraviolet A radiation (brown), photosynthetically active radiation (PAR, green) and infrared radiation (red) for white, grey, crystal and black netting. Data is the mean from three incident solar angles (72, 55 and 38 degrees).



Transmitted solar radiation under white, grey, crystal and black netting at an incident solar angle of 72 degrees (the solar angle in relation to flat roof netting in mid-summer at midday) for 2nm wavelength increments. Data with no netting (that is, unobstructed solar radiation) is also shown.



Percent transmitted solar radiation under white, grey, crystal and black netting at incident solar angles of 72, 55 and 38 degrees.

The light that got through

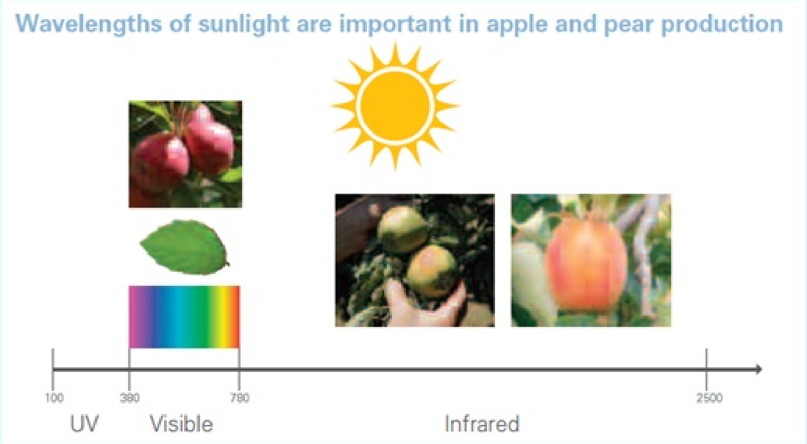
Overall, solar radiation was reduced by approximately 23, 18, 15 and five per cent by the white, black, grey and crystal netting, respectively. The white netting reduced the most radiation attributed to the higher weave density; however, the transmission of radiation through the white (and the crystal to a lesser extent) varied with wavelength. Ultraviolet A, photosynthetically active and infrared radiation were reduced by 34, 28 and 19 per cent, respectively, by the white netting. By contrast, the black netting reduced ultraviolet A, photosynthetically active and infrared radiation by 20, 19 and 18 per cent, respectively.

When the plane of the netting was approximately perpendicular (that is, 72 degrees) to the solar beam, which is similar to the solar angle in relation to flat roofed netting in mid-summer at midday, incoming solar radiation (that is, no netting) peaked at wavelengths of 450–900nm and then steadily declined to 2,500nm, with several troughs at approximately 950nm, 1,150nm, 1,400nm and 1,900nm.

The effects of grey and black netting on the proportion of solar radiation that was transmitted were similar and did not vary with wavelength, whereas the white netting varied with wavelength. The crystal netting had very little impact on incoming solar radiation.

Reducing the incident solar angle reduced the amount of transmitted solar radiation (and its constituent components of photosynthetically active and infrared radiation) under the crystal and black netting. This was most noticeable under the crystal netting. In other words, transmitted solar radiation would be less in the morning and afternoon under flat-roofed crystal and black netting.

Interestingly, transmitted solar radiation under the white netting was similar at the highest and lowest incident solar angle. Additional observations under the netting showed that diffuse radiation more than doubled at the lowest incident solar angle suggesting that under white netting there is no effect of netting roof angle on transmitted radiation due to the scattering of light as it hits the netting filaments.



Wavelengths of sunlight in the visible spectrum drive leaf photosynthesis (400–540nm and 600–630nm) and red colour development in the fruit (430–655nm). Elevated fruit surface temperature from sunlight energy (280–2500nm) has been shown to cause sunburn necrosis. Ultraviolet (UV) radiation of 280–315nm combined with sunlight energy (280–2500nm) causes sunburn browning. Approximately 49 per cent of sunlight energy comes from the infrared spectrum.

Implications for growers

These results have implication for sun damage, photosynthesis and colour development. Red colour development in apples needs light in the range 430–655nm and is stimulated by ultraviolet B radiation (280–320nm). Similarly, the wavebands needed for photosynthesis are 400–540nm and 600–630nm.

On the other hand, sun damage is more associated with the infrared spectrum (> 700nm) as approximately 49 per cent of the energy from solar radiation is from infrared radiation. Results from this study showed that the white netting reduced photosynthetically active radiation more than the reduction in infrared radiation whereas the reduction in photosynthetically active and infrared radiation was similar for black and grey netting. The ideal netting would maintain high values of transmitted photosynthetically active radiation while reducing transmitted infrared radiation across a range of incident angles.

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