Coloured netting for blueberries

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Plants are affected by light in several ways. The quantity and quality of light both affect growth. The direction from which the light comes is another factor and then there is the periodicity of light (daylength) which affects the timing of flower initiation in many crops.

Light enables plants to adapt to environmental conditions. The manipulation of plant form and function using filters to modify light has been tried for years, especially in greenhouses. In the early 2000s, coloured shadecloth designed specifically for manipulating plant growth and development became available. These can be used outdoors as well as in greenhouses and can:

- provide physical protection from birds, hail, insects or sunlight
- modify humidity or temperature
- increase the relative proportion of diffuse (scattered) light
- absorb various wavelengths of light, thereby affecting light quality

These effects not only influence the crop but also the organisms with which they are associated.

Black netting absorbs most light, and white nets, the least. The light that passes through holes in black net remains spectrally unchanged, while light that hits fibres of white and coloured netting scatters and changes spectrally. The modified light spectrum alters plant physiological processes, while scattered light penetrates deeper into the plant between leaves when compared to direct light.

Radiation scattering

Diffuse light has been shown to increase radiation use efficiency, yields and even the time and amount of flowering. Any shadecloth or netting can scatter radiation, especially ultraviolet, because netting is usually made using ultraviolet-resistant plastic. Shadecloth and netting that increases light scattering but does not affect the light spectrum has been shown to increase branching, compactness, and the number of flowers per plant. Coloured shadecloth and netting can also increase light scattering by 50% or more and this alone may influence plant development and growth.

Photoselectivity

Coloured shade nets are being intensively tested primarily because of their ability to manipulate the wavelengths of radiation reaching the crops beneath them. They can be used to change:

- red to far-red light ratios that are detected by phytochromes;
- the amounts of radiation available to activate the blue/ultraviolet-A photoreceptors;
- blue light involved in phototropic responses mediated by phototropins; and
- radiation at other wavelengths that can influence plant growth and development and flowering.

Air movement

Shadecloths and netting also reduce wind speeds and wind run (total distance of the travelled wind over a period of time), which can affect temperatures, relative humidity, and relative carbon dioxide and oxygen concentrations resulting from reductions in air mixing. These changes can affect transpiration, photosynthesis, respiration, and other processes. The effects on air movement depend on the porosity and physical location of the netting in relation to the plants and can be affected by time of day, season, and other factors.

Temperature

Shade nets are often deployed over crops to reduce heat stress; however, in enclosed spaces, temperatures during the day are typically higher than outside and may reach lower than the ambient outside temperatures at night for short periods.

Relative humidity

Relative humidity is often higher under netting compared with outside, as water vapour transpired by the crop is trapped and thus prevented from mixing with the drier air outside.

At certain times this can impede transpiration to the extent that oedema occurs, a condition where epidermal cells burst due to the mismatch between root water uptake and transpiration rate.

Other considerations

There are many factors to consider regarding the use of coloured shade netting besides the direct effects on the crops, these include:

Disease development

Light quality may affect the incidence of pests and diseases – either favourably or unfavourably.

Pollination

Honeybees can get entangled in netting. They may need to be provided with clear entry and exit paths.

Effect on humans

Workers have reported that working under white shadecloth can be hard on the eyes. Coloured shadecloth and netting may also affect picker's ability to judge "ripeness" when harvesting a crop.

Lifecycle costs

Netting factors like relative costs, colour fastness, and durability should also be considered. In recent years, the installation of netting in blueberry crops has increased. Primarily netting is used for bird protection but depending on location, hail may also be relevant.

Black and white netting examples in use on Blueberries in NNSW. Photo credit: Melinda Simpson, NSW DPI

Research specific to blueberries

The use of coloured netting in blueberry production has been explored by several researchers, primarily in Chile and the USA. Following is a review of 3 different trials in 3 locations.

1. **TRIAL 1** was conducted in Miraflores, Chile, which is a coastal location with a maritime climate.
2. **TRIAL 2** was in Goble, Michigan USA where the climate is temperate.
3. **TRIAL 3** was in Georgia, USA where the climate is similar to Perth and northern NSW, with a summer average maximum temperature of over 30°C, a minimum of over 20°C with very high humidity.

It goes without saying that the conditions being sought in each location may be very different and the desired results similarly so.

TRIAL 1: Miraflores, Chile

Some of the earliest work was that of Retamales, Montecino, Lobos and Rojas (2003). In that trial they used black, white, grey and red nets with either 35 or 50% shading plus a control treatment of no net.

In that work, all netting treatments increased yields over that of plants without netting though not all yield increases were statistically significant (Figure 1).

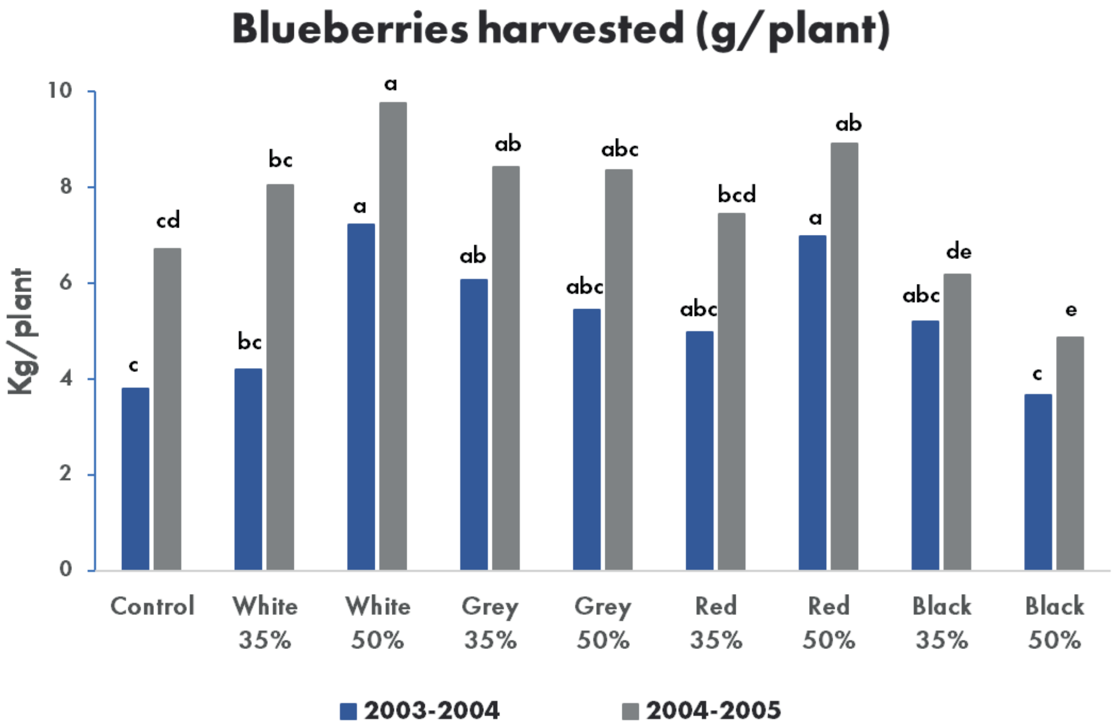

Figure 1. Influence of shading (colour and % shade) on yields (kg fruit/plant) of blueberries cv. Berkeley in the 2003-2004 and 2004-2005 season. Values with the same letter are not significantly different.

TRIAL 2: Goble, Michigan USA

This work was followed up by another set of trials in Michigan over a two-year period in 2006-7 that looked at the productivity and development of blueberry plants cv Elliot under three different colours of photo-selective nets (black, red and white) and three shade intensities (25%, 50% and 75%) plus a control, unshaded treatment.

In this trial, no level of shading improved fruit yield.

This implies that light levels found in the open field in Michigan do not inhibit productivity. This has been supported by other work in Michigan, and also in north-eastern Canada. The authors note that the previous work in Chile contradicts these findings and suggest the higher levels of irradiance and mean temperature typically found during the season in Chile compared to Michigan, put the plants under a greater level of photo-inhibitory stress, where nets could have greater impact. It is also possible that the nets were placed over the plants too late in this study, approximately one month after fruit set rather than right after fruit set, as has been recommended by others.

One very significant finding in Michigan was that shading delayed the harvest date, which could have an impact on profitability.

A similar harvest delay has been reported in other trials with other crops.

Trial 3: Georgia, USA

The third study in Georgia began in the spring of 2016 using a variety called 'Star'. Three photo-selective shade materials were used - red, blue and white; each rated at 50% shading. There was also a control treatment. Fruit was harvested on two separate dates.

Temperatures under the 50% red and blue netting appeared to be lower than the control treatment by up to 3° C. However, the shading treatments did not lower temperature significantly during the latter parts of summer. Temperature under the white shading net was not significantly different from the control during late spring but was significantly higher during summer. Light levels under the red and blue photo-selective shading net treatments were significantly lower than the unshaded control (> 40%) but not under the white shading nets.

Blueberry fruit yield was significantly reduced at the first harvest under the red and blue shading net by as much as 80% compared to the control. Yields from the white shading net treatment was not significantly lower at the time of harvest. Fruit yields at the second harvest were not significantly different between treatments (Figure 2).

This project also concluded that coloured netting appears to delay cropping.

There were also significant effects on aspects of fruit quality, for example the ratio of the soluble solids to titratable acidity (an indicator of fruit flavour), was reduced by as much as 26% in the red and blue shading treatments.

The authors of this trial stated an intention to continue the work to determine the impacts of netting over the longer term. As the first trial was held in 2016, I have contacted them to see if further results are available but have yet to receive a reply.

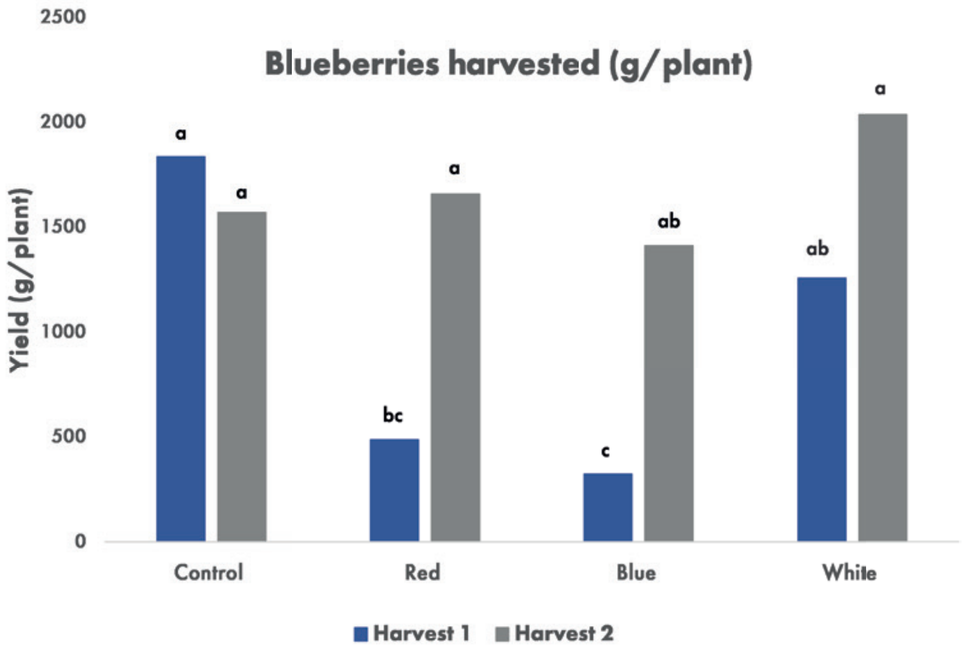

Figure 2. Blueberry fruit yield (g) under control and photo-selective shading netting treatments. Values with the same letter are not significantly different.

Summary

White or black are the shadecloth/netting colours presently in use in the blueberry industry in Australia. However, most netting sold is Australia is used for bird protection and only has an 18-20% shade factor.

Black shadecloth/netting absorbs the most light and thus shades the plants the most, while white absorbs the least.

The light that passes through the holes in black shadecloth/netting remains spectrally unchanged, while the light under white netting is diffused, penetrating deeper into the canopy of the blueberry plant between leaves compared to direct light.

Yields are most likely to be adversely affected by black netting with 35% probably being the upper limit.

The use of coloured (red, blue) shadecloth/netting on blueberries is likely to delay cropping, at least in the short term and may adversely impact on yields.

The impact of lower shade levels such as that used in bird netting is not known but it is likely the reduced losses from bird damage would outweigh anything else.