Using photoselective plastic films in the production of leafy salads in Wales

Figure 1. Example of the small-scale polytunnels used the project trials.

Leafy salad crops can be valuable crops for horticultural growers with high yields and short cropping cycles. Developing new materials for skinning polytunnels can offer potential benefits to growers.

Manipulation of the light spectrum reaching a crop can enrich certain portions of the spectrum, such as blue-enrichment, to modify plant development, or blocking UV light to reduce pest and disease development.

Introduction

Early polytunnel plastics were designed to get as much light as possible to the crop, but innovations in plastic technologies have produced new materials with novel properties to enable new ways of controlling plant growth. The EIP Wales project 'Using photo selective films to enhance the profitability of leafy salad production in Wales' was set up in 2020 to trial the effect of using different photoselective plastics in the production of leafy salads.

Photoselective Plastics & Light Quality

Sunlight is made up of a broad mixture of wavelengths, including visible light (blue to red), ultraviolet and infrared (Figure 2). While only certain wavelengths are absorbed for photosynthesis (photosynthetically active radiation, or PAR), plants will use other wavelengths to control their growth and development, using light as ques to help them adapt to their environment. For example, increased UV light can stimulate plants to make purple pigments and antioxidant compounds, whilst changing red and far red intensities can change how leaves and shoots orientate themselves. Light quality can also impact other organisms, particularly certain pests and diseases, changing how behave.

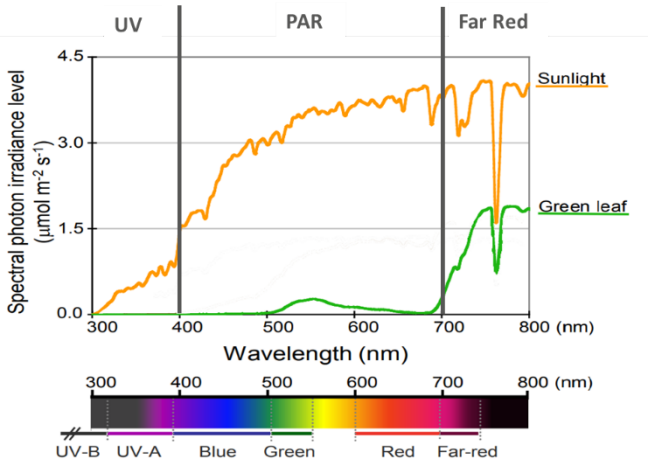

Figure 2. Light wavelengths and plants. Adapted from Kami *et al.*, (2010)

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig:
Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development:
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Innovation in plastic technologies has enabled tunnel skins to be formulated which change the quality of light passing through to benefit from these effects without having the high costs of other light modifying technologies such as LED systems. Photoselective plastics can be used in a variety of uses, ranging from small, temporary tunnels to large permanent tunnels used for a full season. However, it is necessary to understand the benefits of the new plastic materials, and any challenges that might be posed for their uses.

Project Design

The project set out to test a range of photoselective plastics at two commercial grower sites in North Wales over the course of three growing seasons. The different plastics used in the trial are summarised in **Table 1** below. These were chosen on the potential to achieve a variety of affects, alongside the inclusion of a clear plastic and a bare ground control to allow comparisons with typical production methods. All the plastics are commercially available. Low 1x3m polytunnels were skinned with each plastic and used to cultivate three lettuce varieties – Green Oak Leaf, the red Lollo Rosso and yellow Lollo Bionda – which showed a range a desirable head shapes, leaf textures and colours. The small tunnel was selected to demonstrate how these plastics could be used on small and micro scale to suit business needs.

Table 1. Photoselective plastics used in the trial. A clear plastic and a bare ground treatment was included for comparison as a control.

Plastic	Properties	Proposed Benefits
Clear	Conventional clear plastic.	Microclimate modification, high light transmission.
Diffuse	High light scattering.	Increased light penetration into closed canopy, improved older leaf condition.
Blue	Absorbs red and green portion of the spectrum, transmitting blue light.	Compact habit and enhanced colour development in pigmented leaves.
UV Blocking	High transmission light transmission but UV blocking.	Enhanced pest and disease control.
Untreated	Bare ground	N/A

Results

The results showed that while photoselective plastics can offer a range of benefits, these vary between season, variety and growing conditions. In spring and autumn plantings, plastic use had clear benefits over bare ground, with particularly strong growth under UV blocking plastic (Figure 3). However, differences in yield were less pronounced in the summer months, with increased yields on bare ground.

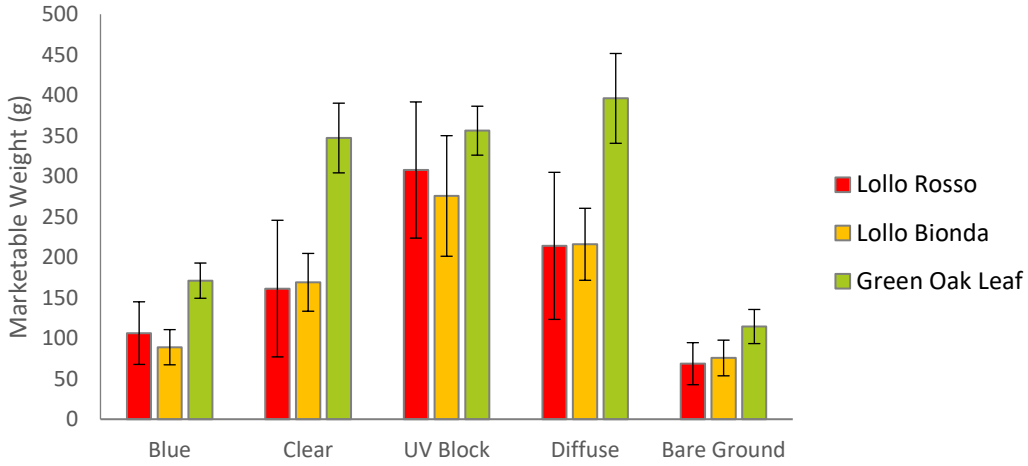

Figure 3. Individual marketable head weight, autumn planting 2020.

Quality scores were similar between treatments, although the diffuse plastics showed small uplifts in quality in the autumn plantings, particularly due to head shapes for the Lollo varieties. Green Oak Leaf and Lollo Bionda colour did not show a significant response to plastic choice, but colouring of Lollo Rosso showed a strong response to plastic choice (Figure 4). Strongest colours were seen under the blue and diffuse plastic, but weakest colour given under the UV blocking plastics. Representative photographs of lettuce given in Table 2.

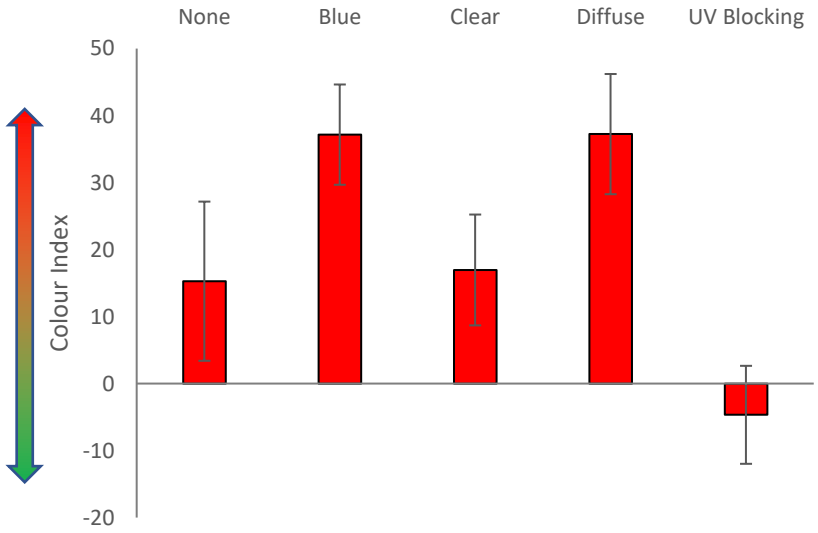

Figure 4. Colour Index scores for Lollo Rosso. More positive values give a strong depth of red, with smaller (or more negative) values showing deeper green.

Seasonal effects were strong, however, with less clear differences between plastics seen in the summer months. Control of humidity, particularly in the summer months, was difficult in the low tunnels used, so it would be recommended that tunnels are used which can be open at the sides or ends during warm periods to

keep humidity down. Pest and disease problems were not encountered during the trial, but the UV-blocking plastic may be of greater benefit for crops vulnerable to fungal diseases such as *Botrytis*.

Table 2. Photographs of lettuce varieties at harvest, autumn 2020.

	Untreated Control	Clear	Blue	Diffuse	UV Blocking
Green Oakleaf					
Lollo Rosso					
Lollo Bionda					

Postharvest lifespans of crops harvested from under each plastic were relatively similar, although these were all improved compared with bare ground. Plants grown under clear plastic showed the smallest declines in quality compared with the photoselective plastics, although the UV blocking showed the most rapid decline. However, given lettuce crops perform best with short supply chains supplied directly to customers, shelf life is less of a concern compared with initial product quality.

The project also looked at the ability of the photoselective plastics to retain their light-modifying properties over three years of use in the field. Spectral measurements showed no changes in transmission quality, indicating that these materials can be used for many consecutive seasons without degradation. Manufactures' recommendations are that plastic can last up to 8-10 years, particularly when protected from bad weather over the winter months, and so growers can remain confident that these materials will

Growers would also be recommended to consider the range of crops that they are likely to want to grow under plastic, as this will dictate which is the best choice for the holding. Products with strong colours, particularly purples and reds, may not show the greatest colour when grown under UV-blocking plastic, although this can give good yields and strong quality harvest for green varieties. Similarly, diffuse plastic may be of benefit for dense, compact crops for which light reach down into the canopy will help plants to develop fully.

Conclusions

This project demonstrated several trends relating to the use of different types of plastic use for leafy salad production.

- One clear trend is the benefits of protected cultivation compared with bare ground cultivation. This was particularly evident in the spring trial at the start of 2022 where practically no yields were achieved from bare ground cultivation at either site compared plastic treatments.
- There were several trends relating to light modifying plastic in the trials. In 2020, the UV-blocking plastic gave a strong increase in head weight for both Lollo Rosso and Lollo Bionda, whilst the diffuse plastic gave an uplift in yield for Green Oak Leaf. UV-blocking plastic also gave an increase in yield in the spring 2022 trials.
- Head colour was most significantly impacted by plastic treatment, although this was linked with variety choice. Colour development for the red Lollo Rosso was stronger under blue and diffuse plastics, although colour was less intense under UV-blocking plastic despite the greatest yield.
- Specialist plastics will cost c. 15% more than standard clear plastic, and this would need to be taken into consideration. Growers would be advised to think carefully about what demands are likely to be placed on a polytunnel over an 8+ year-lifespan to make sure they can maximise the benefits of their investment.
- Plastic choice may impact crops which require pollinator activity (e.g., strawberry, tomato), particularly the blue and UV-blocking which can impact insect flight.
- Plastics may be particularly beneficial for propagation and early plant raising, particularly for field crops such as pumpkin which can be sown early under plastic before planting out.
- The ability to improve growing conditions around crops, and potentially reduce pest and disease proliferation, could offer growers a low energy, chemical free way to improve crop performance. It could also improve water management and the need for irrigation by controlling water loss from plants and soil during hot, dry periods.
- Growers may also be concerned about the additional use of plastics impacting the environmental sustainability of their systems. The long lifecycle of these plastics coupled with the use of available industry recycling schemes means the materials can be used in a sustainable way. Typical manufacture’s specifications are for eight or more years of life expectancy, with at least five years of UV manipulation.