Ultraviolet Blocking Greenhouse Polythene Covers for Insect Pest Control on Organic Crops:

May 2003 – September 2004

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Caiff y Ganolfan Ddatblygu Organig, a gaiff ei rhedeg gan Ganolfan Organig Cymru, ei rheoli gan Awdurdod Datblygu Cymru ar ran Llywodraeth Cynulliad Cymru fel rhan o Cyswllt Ffermio.

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1. Summary:

This report reviews the development work carried out within the 'UV Blocking Polythene Trial' on the organic farm at the Welsh College of Horticulture during the period May 2003 to September 2004.

Two tunnels were erected in 2003, one covered in UV blocking 'Sterilite' film and the other in the non-UV blocking 'Super Strength 600'. The salad/brassicas crops grown during the first season under the UV blocking film showed significantly less pest attack (both winged and non-winged pests). Less aphids were present and their 'flight behaviour' was greatly reduced under the UV blocking film. The crops under the UV blocking film also appeared to establish quicker and reached a greater final size.

Two more tunnels were erected in spring 2004 and covered in identical films. All four tunnels were then cropped with tomatoes, peppers and cucumbers. The level of pests in all crops/tunnels was generally very low during the season and there was no apparent significant difference in pests under the two different films. Blue and yellow sticky traps caught noticeably more insects under the non-UV blocking film and this highlighted either a greater population level, and/or an increased level of flight activity under that film.

The report draws conclusions from the trials and makes recommendations for the 2005 research.

2. Acknowledgement

Edward Miles (Higher National Diploma in Organic Horticulture student and part-time organic farm worker at WCoH) for looking after the tunnels/crops on a day-to-day basis and for his assistance in the monitoring and the records of his observations.

We would like to thank Farming Connect, who provided financial support for this project through its Organic Development Programme.

3. Introduction:

3.1 Overview of Current Knowledge:

The use of UV-blocking polythene is now widely known to be an effective method in reducing many flying insect pests. UV light filtration interferes with flight orientation of insects therefore reducing numbers entering greenhouses and it also limits the activity of those that do enter and hinders their ability to disperse once inside (see initial project proposal for more detailed information and references).

3.2 Aim of the Development Work:

To evaluate the effectiveness of UV polythene filters as a means of flying insect pest control within small-scale organic horticultural cropping systems (i.e. typical of many such systems/holdings within Wales).

3.3 Objectives of the Development Work:

- Grow a range of organic vegetable crops within greenhouses covered in UV and non-UV blocking films.
- Use production systems comparable to those employed by other organic growers within Wales.
- Collect indicative evidence on the level of insect pests within the different greenhouses.
- Visually assess the level of pest infestation on the crops grown under the different polythene films.
- Make note of any other differential cropping factors between the two polythene films.

4. Methodology:

4.1 Broad Methodology:

Ultraviolet (UV) light absorbent polythene film was used as a tunnel cover over 'organically' grown vegetable crops. The incidence (i.e. population levels and distribution), infestation and damage to the plants by flying insect pests was observed over growing seasons and compared to identical crops grown in adjacent tunnels covered in a non-UV blocking tunnel film. The overall growth and performance of the crops grown within the tunnels was also monitored.

4.2 Year 1 (2003-04):

Two adjacent single-span tunnels were constructed in April 2003 within the Organic Farm at WCoH. One was covered with UV-blocking film 'Sterilite HDF' and the other with a comparable non-UV blocking film 'Super Strength 600 HDF'. Both films produced and supplied by 'XL Horticulture'.

Each of the two tunnels was divided into two beds with a central path, with different crops in each bed. The two tunnels being cropped identically in both varieties and quantities of plants (Figure 1).

Figure 1: Table of varieties cropped in the two tunnels May 2003 to March 2004

Left Beds – Salad Crops	Right Beds - Brassicas
• **Chard** • **Chicory** • **Claytonia (Winter Purslane)** • **Endive** • **Winter Lettuce** • **Winter Spinach** **NB: All crops planted as module grown transplants except Swiss Chard, which were transplanted from outdoor plots.**	• **Chinese Cabbage** • **Komatsuna** • **Mizuna** • **Pak Choi** • **Quarantina** • **Rocket** • **Spring Cabbage** • **Tatsoi** • **Winter Radish** **NB: All planted as module raised transplants, except for Mizuna, Rocket and Winter Radish, which were sown direct (8/10/03).**

4.3 Year 2 (Spring 2004 onwards):

Two more identical single-span tunnels were constructed in November 2003 (Figure 2) and these were covered with identical films to the other two tunnels. This allowed for 'replication' between treatments. The older tunnels (1 & 2) were cleared in May 2003 and then all four were planted with a range of salad crops between 14th May – 11th June 2004 (Figure 3).

Monitoring was carried out regularly by the staff on the farm and yellow and blue 'Sticky Traps' were also situated within each of the 4 tunnels at crop height in order to assess the numbers of insects flying within the greenhouses. These 'traps' were then changed twice during the cropping season.

Figure 2: The 4 tunnels within the Organic farm at WCoH (photo taken June 2004). The tunnels are numbered 1 to 4 from left to right. 1 & 3 are covered with UV-blocking 'Sterilite HDF' and 2 & 4 with the non UV-blocking 'Super Strength 600 HDF'.

Figure 3: Table of varieties cropped within the 4 tunnels in spring/summer 2004

Tunnels	**Left Bed**	Right Bed
Tunnels 1 & 2	Cucumbers: Majority planted 17/5/04 OCW seed trial varieties planted 11/6/04 (*)	**Sweet Pepper & Capsicum (pointed, blocky):** **Planted 11/6/04**
Tunnels 3 & 4	Tomatoes (cherry, classic & plum): Non seed trial varieties (*) planted: 14/5/04	**Tomatoes (cherry, classic & plum):** **OCW seed trial varieties (*) planted: 11/6/04**
**** WCoH also carried out a 'seed trial' for OCW during 2004 and some of these varieties were grown within the polythene tunnels. Therefore in effect taking part in both trials projects.***		

5. Results:

5.1 Year 1 Trials:

5.1.1 Pest Levels:

The Brassica crops grown in Tunnel 2 (non-UV-blocking film) all had a significantly higher level of damage done by 'eating' of the foliage by pests – mainly slugs (Figures 4 to 7). There was also a slight powdery mildew attack on the Pakchoi, which appeared at the same time in both Tunnels 1 & 2.

Figure 4

Figure 5

Figure 6

Figure 7

Figures 4 & 6 (Tunnel 1: UV-blocking film) and **Figures 5 & 7** (Tunnel 2: non UV-blocking film), representative photographs showing the significantly higher level of eating damage to the leaves on the crops grown under the non UV-blocking film (Photos taken 14/12/03).

On the salad crops; A 'significant' aphid population was first seen in Tunnel 2 (non UV-blocking) in mid-April and this soon increased, particularly on some 'bolted' flowering shoots of chicory. All the salad plants were removed from Tunnel 2 on 17/5/04, except for the Rocket. Aphid numbers increased dramatically on the Rocket plants within Tunnel 2 before their final removal (Figures 8 & 9).

No aphids were seen in Tunnel 1 (UV blocking) until a month after they were first observed in Tunnel 2. At the time the crops were removed in mid/late May there were significantly less aphids within Tunnel 1 and this was highlighted by the number of migratory winged alatae on the inside of the tunnel films at the end of the cropping (Figures 10 & 11).

Ladybirds (adults and larvae) were present in both tunnels, but numbers were noticeably higher in Tunnel 2. NB: Downey Mildew soon appeared on the foliage of lettuce in both tunnels.

Figures 8 & 9 (taken 18/5/04) showing the aphid infestation on lettuce and Rocket plants in Tunnel 2 (non UV-blocking film).

Figures 10: Tunnel 1: UV-blocking film) showing no winged migratory alatae compared to relatively high numbers on the non UV-blocking film (See Figure 11)

Figures 11: showing the high numbers of winged migratory alatae present on the non UV-blocking film, compared to none (zero) over the entire UV-blocking film (see figure 10).

5.1.2 General Crop Growth:

Brassicas: Despite direct sowing all the seeds on the same day within both tunnels, the radish in Tunnel 2 emerged 2 days after the radish in Tunnel 1 (UV blocking). The development of all crops under the UV blocking film was noticeably quicker and the final size of the crops was also greater. The size differential was greatest with the lettuce crops (Figures 12 & 13). The lettuces under the UV blocking film therefore reached a much larger size before Downey Mildew took hold. This therefore meant that after the removal of infected leaves, there was a much greater head of lettuce that was saleable.

Figures 12 (left – Tunnel 1: UV-blocking film) and Figure 13 (right – Tunnel 2 non UV-blocking film) showing the increased crop size of the plants grown in the UV-blocking tunnel. This was representative of all crops within the two tunnels, (which were all planted at exactly the same spacing) but was most significant with the lettuces. NB: compare the soil area visible in the two photographs.

5.2 Year 2 Trials:

5.2.1 Pest Levels:

Low numbers of aphids were found on the tomato and cucumber plants, but the level of infestation appeared not to be significantly different in either of the two treatments and the small populations of aphids that were discovered disappeared during the growing season.

The Sweet Peppers suffered from attack from both slugs and an 'unidentified' beetle that chewed holes in both the foliage and the fruit, mainly on the shoulder of the fruit near the calyx (Figure 14). There was, however, no apparent difference in the level of damage between the two treatments.

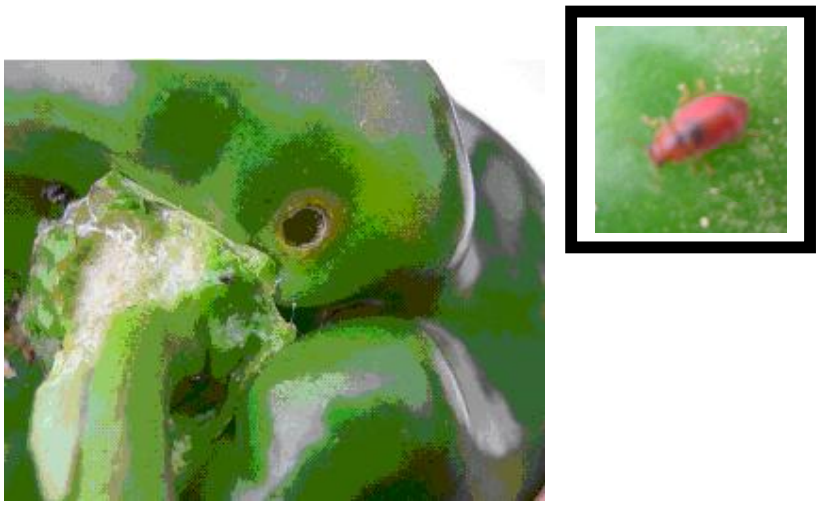

Figure 14: Damage done to Sweet Peppers by both slugs and an 'unidentified' beetle (top right). There was no apparent difference in the level(s) of damage between the two treatments (Photos: Edward Miles).

A higher number of flying insects were caught on the yellow and blue 'Sticky Traps' (predominantly more on the blue traps) that had been suspended in the tunnels covered in the non-UV blocking film (Figures 15-18), but no precise data was collected in relation to precise numbers and the exact types of insects trapped.

Figures 15-18: Photographs of all the 'Sticky Traps' removed from the 4 tunnels during the trial period (i.e. 8 from each tunnel; 2 x yellow and 2 x blue at one time, which were then removed and replaced with 2 more of each colour). The comparable traps in terms of time periods within the tunnels are positioned vertically beneath each other below. More detailed examples of comparable traps are shown in Figures 19 & 20 over the page.

Figure 15 (above): Tunnel 1 covered in the UV blocking film 'Sterilite'

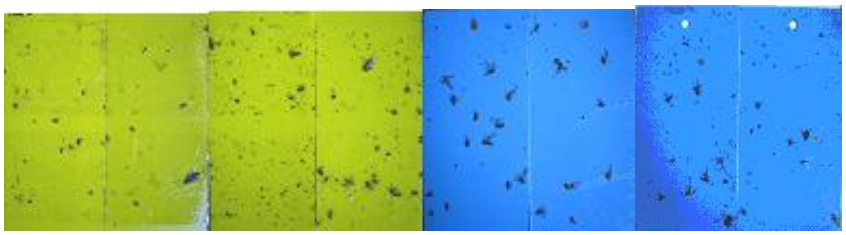

Figure 16 (above): Tunnel 2 covered in the non-UV blocking film 'Superstrength 600'

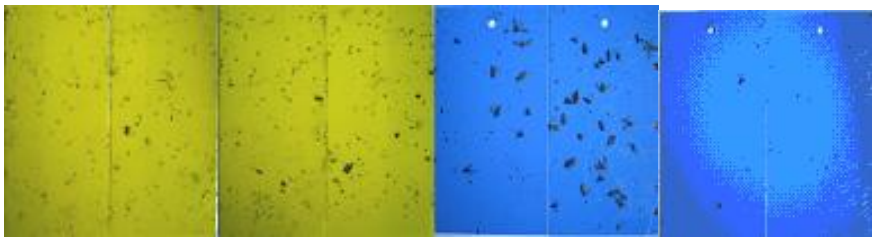

Figure 17 (above): Tunnel 3 covered in the UV blocking film 'Sterilite'

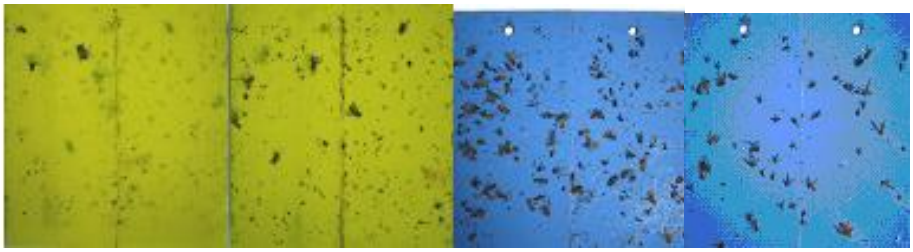

Figure 18 (above): Tunnel 4 covered in the non-UV blocking film 'Superstrength 600'

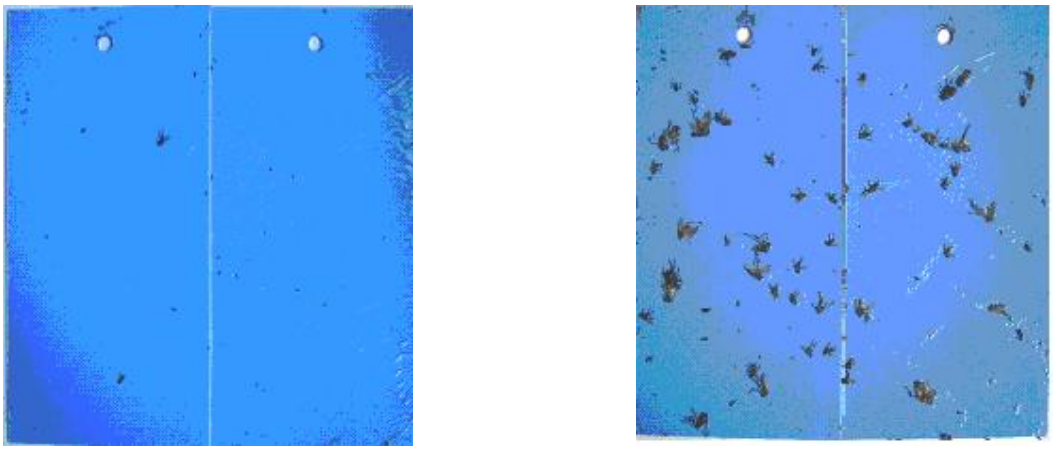

Figure 19: Blue Sticky traps removed from 'Sterilite' covered Tunnel 3 (left) and 'Superstrength 600' covered Tunnel 4 (right). Both were in place in a similar situation within each tunnel and for exactly the same time period.

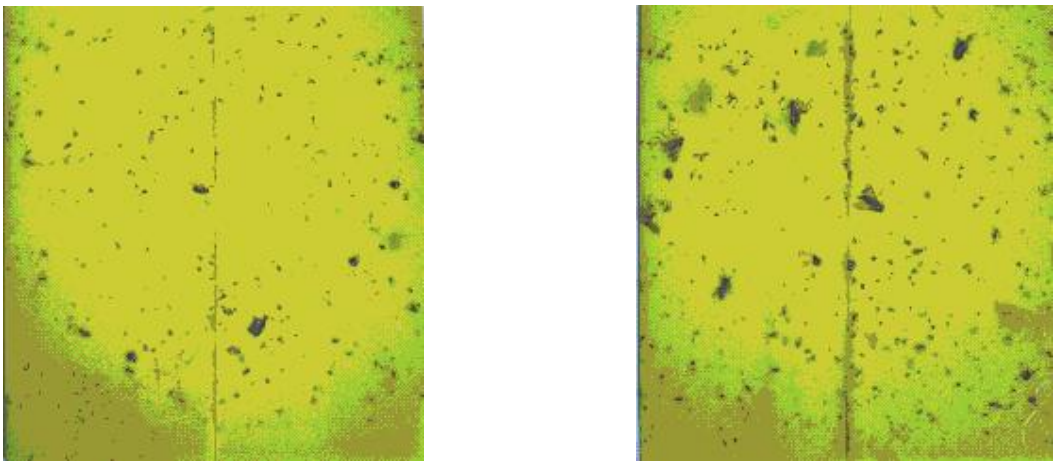

Figure 20: Yellow Sticky traps removed from 'Sterilite' covered Tunnel 3 (left) and 'Superstrength 600' covered Tunnel 4 (right). Both were in place in a similar situation within each tunnel and for exactly the same time period.

5.2.2 Disease Level:

Botrytis was noticed in Tunnel 3 during week commencing 16th August, but soon after noticed in Tunnel 4 as well. There appeared to be no significant difference in the level of botrytis infection in the two tunnels during the trials period.

5.2.3 General Crop Growth:

With the tomatoes, the 'density' of the foliage of the plants within Tunnel 3 (UV-blocking) appeared to be greater than in Tunnel 4. This was noted while removing lower leaves and stopping the plants during weeks commencing 16th and 23rd August 2004. With the cucumbers, there was a 'distinct difference' between the growth and health of the plants in Tunnels 1 and 2. From planting those in Tunnel 2 (non UV-blocking) were slow to develop

and soon also showed symptoms of mineral deficiency (thought to be Potassium). The plants in Tunnel 1, however, grew much more vigorously, looked healthy and fruited well. The peppers grew well, with no apparent difference with the crops in the two treatments (NB: no measurements were made in respect to crop growth and/or yield).

Figure 21: Showing a general representation of the crops grown in the four tunnels. The top photos show the right and left beds of Tunnels 1 & 2 and the lower photos show the crops grown in the right and left beds of Tunnels 3 & 4.

6. Discussion:

6.1 Discussion of Results:

6.1.1 Year 1 Trials (May 2003 – March 2004) – 2 Tunnels:

A very wide range of salad crops and brassicas were grown in the two tunnels and perhaps there was too great a range to accurately mirror a 'commercial cropping' situation. However, for small scale AYR salad leaves production it could be classed as being representative.

The crops under the non-UV blocking film all exhibited a significantly higher level of slug & snail damage. This is hypothesised to be purely as a result of 'random chance', however

the difference in the level of damage on the crops under the two films was so marked that further investigation would be advisable.

Significantly more aphids were certainly present on the crops grown under the non-UV blocking film and the few aphids that did appear under the UV blocking film appeared much later and did not become a significant problem. There high level of aphids on the inside of the non-UV blocking film (compared to none on the UV blocking) is presumed due in part to the higher level within the tunnel, but also that during 'migratory flight' aphids are stimulated to take off towards UV light. Therefore any that were present would not be attracted upwards and towards the polythene in the UV blocking tunnel.

All these points indicate that the UV-blocking film was reducing the level of aphids under it as well as their flight activity. Again, however, 'random chance' could be the reason and repetition and longer-term trials will be needed to draw more conclusive evidence. The apparent higher population level of ladybirds present under the non-UV blocking film can be attributed to the higher level of available food (i.e. aphids) under that film and not to the effect of the UV blocking.

The crops under the UV blocking film appeared to grow quicker and also reached a greater final size. There is no previous scientific evidence to suggest that crops grow better under UV blocking films and this is therefore likely to be due to a slight difference in the aspect and/or soil conditions, or the actual cropping practices/husbandry carried out within the two tunnels

6.1.2 Year 1 Trials (May 2003 – March 2004) – 4 Tunnels:

No significant difference in pest levels was noted on the crops in the four tunnels during the cropping season. However, the level of pests was regarded as generally being 'very low' and so this result is inconclusive. More flying insects were trapped on the sticky traps in the non-UV blocking tunnels (particularly on the 'Blue' traps) and this could indicate that either there were more flying insects in these tunnels, or that there was greater 'flight activity' under the non-UV blocking film.

As with the first trial, the crops grown under the UV blocking film appeared to grow away quicker and also grew to a greater final size. The lack of analytical growth data however,

means that no level of significance can be claimed. The fact that both trials indicated greater crop growth under the UV blocking film suggests that further research into the effect on crop growth is justified.

6.2 Conclusions:

6.2.1 The level of pests, both flying and non-flying, was noticeably less within the tunnels covered in the UV blocking film.

6.2.2 The flight behaviour of insects was less under the UV blocking film.

6.2.3 The speed of growth and eventual final size of the crops appeared to be greater within the tunnels covered in the UV blocking film.

6.3 Recommendations:

6.3.1 The trials must be repeated for the next growing season. Some crop varieties could be changed, but the overall cropping programme should remain very similar.

6.3.2 Specific growth measurements must be taken from the crops. This should be a measure of crop height, spread and weight. For the tomatoes and cucumbers an accurate figure for yield (weight) must be recorded.

6.3.3 More scientific basis should be given to the counting and recording of the flying insects (both pests and beneficial) within the tunnels.

6.3.4 The individual tunnels must be monitored for climatic differences (e.g. temperature & humidity), which will provide data relative to the crop growth and development.

6.3.5 The level of slug/snail infestation and impact should be monitored.

NB: The longer the tunnels are in production (i.e. number of growing seasons) the higher the latent pest population will become. This will then provide more useful data year on year.