Ultraviolet-blocking Greenhouse Plastic Films for Management of Insect Pests

Heather S. Costa¹

Department of Entomology, University of California, Riverside, CA 92521

Julie Newman²

UC Cooperative Extension, 669 County Square Dr, Ventura, CA 93003

Karen L. Robb²

UC Cooperative Extension, 5555 Overland Avenue, Building 4, San Diego, CA 92123

Additional index words. *Trialeurodes vaporariorum*, whiteflies, thrips, aphids, leafminers, cultural control, lisianthus, *Eustoma grandiflorum*

Most greenhouse polyethylene plastic films contain ultraviolet (UV) light-blocking components added to prolong the life of the material and maintain high levels of transmission of photosynthetically active radiation (PAR). Standard greenhouse films generally block the majority of UV light transmission at wavelengths below 360 nm; however, some materials block a greater portion of the UV light spectrum by blocking transmission below 380 nm (Antignus et al., 1996; Costa and Robb, 1999).

Previous studies conducted in completely enclosed greenhouses reported reductions in whitefly, aphid, and thrips infestations in vegetable crops grown under <380-nm blocking plastic compared to those grown under <360-nm blocking plastics (Antignus et al., 1996, 2001). The presumed method of insect population reduction is the alteration of normal UV wavelength patterns used by insects during orientation and flight (Antignus, 2000; Antignus et al., 1996, 2001). When silverleaf whitefly (*Bemisia argentifolii* Bellows and Perring), greenhouse whitefly (*Trialeurodes vaporariorum* Westwood), or western flower thrips [*Frankliniella occidentalis* (Pergande)] were released in small, completely enclosed tunnels, sticky trap catches were lower under <380-nm plastics than <360-nm plastics, indicating a preference to enter tunnels that transmitted more UV light (Costa and Robb 1999; Costa et al., 2002).

Greenhouse structures in Southern California and other moderate climates often have sides or roof vents that open to allow natural ventilation and cooling. A previous study on flowering crops conducted in small (4 × 8 × 3 m) open-sided hoop-houses found significantly

lower numbers of aphids and thrips under <380-nm plastic compared to crops grown under standard <360-nm plastic (Costa et al., 2002). However, the relative differences were not as great as reported for enclosed structures, and there was no difference in the numbers of whiteflies present. Those results suggest that the effect on insects was diminished in structures with open sides. The objective of this study was to determine if increasing the size of the covered area might increase the effectiveness of <380-nm UV-blocking plastic in managing insect populations in open-sided structures by reducing the proportion of the total area impacted by the open sides. Thus, the present study used a much larger covered area for each treatment than previous trials.

A permanent 1.2-ha greenhouse range (ridge and furrow, gutter-connected, arch roof; Conley's, Montclair, Calif.) located in Oxnard, Calif., was used for this study. The upper-half of the greenhouse sides (≈3 m) was opened for ventilation, and roof vents were located about every third bay. There were 11 "planting areas" cropped on about a 2-week planting cycle. Each planting area consisted of four greenhouse bays, each 6 × 45 m, with four planting beds per bay. About 6000 plugs of lisianthus (*Eustoma grandiflorum*) were transplanted into each bed.

One-half of each planting area was covered with standard <360-nm blocking greenhouse plastic (6 mil, Clear Polyethylene UVA; Ginegar Plastic Products, Israel), and the other half with a <380-nm blocking material of the same weight (6 mil "Sun Selector Anti Virus", Ginegar Plastics Products). The <380-nm plastic transmitted significantly less UV light in the 250–400-nm range ($5 \pm 1 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) than the <360-nm plastic ($28 \pm 1 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) ($t = 14.91$, $df = 38$, $P < 0.001$). There was no significant difference between the <360-nm plastic ($543 \pm 23 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) and <380-nm plastic ($530 \pm 31 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) in the level of visible light transmitted in the 400–700-nm range ($t = 0.34$, $df = 36$, $P < 0.74$), which covers the range of PAR needed for plant growth.

The experimental design was a complete block, replicated three times, with three to four planting areas used for each replicate (≈1500–2000 m² for each treatment, in each replicate). Insect populations were monitored

with six to eight yellow sticky traps per treatment (each 10 × 18 cm; Seabright, Emeryville, Calif.) adjusted to plant canopy height. Traps were replaced and the number of insects recorded weekly. In addition, three leaves from five plants per bay (30–40 plants per treatment) were randomly sampled weekly and the total number of insects present was recorded.

Greenhouse whitefly and western flower thrips were the dominant insect species observed in these trials. Over the course of the three replicates, the mean number of whiteflies and thrips trapped on sticky cards under the <380-nm plastic-covered houses was not significantly different from the number trapped under the standard <360-nm plastic (whiteflies: $F = 0.64$, $df = 1374$, $P = 0.426$; thrips: $F = 2.14$, $df = 1374$, $P < 0.145$). Similarly, there was no significant difference in the mean numbers of whiteflies ($F = 0.08$, $df = 1374$, $P = 0.777$) or thrips ($F < 0.01$, $df = 1374$, $P < 0.963$) counted on plants under the two types of plastics. However, the mean number of leafminers (*Liriomyza* sp.) trapped on sticky cards and counted on plants under the <380-nm plastic-covered houses was significantly lower than the number trapped under <360-nm plastic (cards: $F = 26.81$, $df = 1374$, $P < 0.001$; plants: $F = 14.35$, $df = 1374$, $P < 0.001$). Aphid populations were too low to make meaningful statistical comparisons.

In a previous study using smaller open-sided greenhouses, we found that populations of thrips were lower under <380-nm plastics compared to <360-nm (Costa et al., 2002). However, no effects on thrips populations were observed in this study. Thus, it appears that increasing the overall covered area did not increase the effectiveness of the <380-nm plastic in reducing insect pests. In the open-sided greenhouses the presence of some unfiltered light and the passive movement of insects into the greenhouses by wind may have reduced effects of the UV-blocking materials.

The benefits to integrating the use of high-UV-blocking plastics into an existing pest management program will vary with the type of greenhouse structures used and types of insect and disease pressures commonly encountered. The effect of the high UV-blocking material on insects has been greatest when used in completely closed structures with little or no unfiltered light entering the system.

Literature Cited

- Antignus, Y. 2000. Manipulation of wavelength-dependent behaviour of insects: An IPM tool to impede insects and restrict epidemics of insect-borne viruses. *Virus Res.* 7:213–220.
- Antignus, Y., M. Lapidot, N. Mor, R. Ben-Joseph, and S. Cohen. 1996. Ultraviolet absorbing plastic sheets protect crops from insect pests and virus diseases vectored by insects. *Environ. Entomol.* 25:919–924.
- Antignus, Y., D. Nestel, S. Cohen, and M. Lapidot. 2001. Ultraviolet-deficient greenhouse environment affects whitefly attraction and flight-behavior. *Environ. Entomol.* 30:394–399.
- Costa, H.S. and K.L. Robb. 1999. Effects of ultraviolet-absorbing greenhouse plastic films on flight behavior of *Bemisia argentifolii* (Homoptera: Aleyrodidae) and *Frankliniella occidentalis* (Thysanoptera: Thripidae). *J. Econ. Entomol.* 92:557–562.
- Costa, H.S., K.L. Robb, and C.A. Wilen. 2002. Field trials measuring the effects of ultraviolet-absorbing greenhouse plastic films on insect populations. *J. Econ. Entomol.* 95:113–120.

Received for publication 7 May 2002. Accepted for publication 30 Jan. 2003. Research assistance by T. Pinckard and J. Rodgers, and the cooperation of Pleasant Valley Nursery, Oxnard, Calif., is gratefully appreciated. This project was funded in part by Univ. of California IPM Program, the Hansen Trust, and the California Dept. of Pesticide Regulation. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the Univ. of California and does not imply its approval to the exclusion of other products or vendors that also may be suitable.

¹Associate Entomologist and CE Specialist.

²Floriculture and Nursery Crops Farm Advisor.