UV-Transmitting plastics reduce powdery mildew in strawberry tunnel production

Helen Newman, Berry Industry Development Officer, Agricultural Produce Commission

This article summarises the findings of research published in The American Phytopathological Society Journal of Plant Disease in September 2022: Onofre, B., Gadoury, D., Stensvand, A., Bierman, A., Rea, M., and Peres, N. (2022), UV-Transmitting plastics reduce powdery mildew in strawberry tunnel production, Plant Disease 106:2455-2461, The American Phytopathological Society.

- Results of this research indicate that the exclusion of UV radiation by certain plastics is a major factor in disease development in protected cropping systems
- Exclusion of solar UV radiation is a principal factor in contributing to higher disease severity
- Disease severity for crops covered with film transmitting 80% of solar UV-B was significantly lower than the UV-blocking film types
- Marketable yields were significantly higher under the UV transmitting films compared to standard polyethylene

Strawberry powdery mildew can be particularly destructive in protected cropping systems, which are generally constructed of materials that block ultraviolet solar radiation. This research compared powdery mildew development under standard polyethylene, which blocks nearly all solar UV-B, and two formulations of ethylene tetrafluoroethylene (ETFE), one of which contained a UV blocker and another that transmitted nearly 90% of solar UV-B.

Many previous studies have considered the more favourable temperature and relative humidity conditions prevailing in protected cropping systems compared with open-field systems as principal causes of higher powdery mildew severity. This research has shone a light (pun intended) on the role UV radiation plays, showing that exclusion of solar UV radiation is a principal factor contributing to higher disease severity.

Experiments were conducted at the University of Florida Gulf Coast Research and Education Centre in Wimauma, Florida over two consecutive seasons. Bare-rooted runners of strawberry cultivar *Florida127*, known for its high susceptibility to powdery mildew, were used in the experiments. Runners were planted into plastic-mulched raised beds with small tunnels placed over the top of treatment plots (Figure 1). Treatments were open-field (no plastic cover), UV-B-transmitting ETFE film (F-Clean Clear), UV-B-blocking ETFE film (F-Clean Gruv), and standard polyethylene film (Polyethylene).

The total diffuse spectral transmittance of each plastic film was measured under laboratory-applied UV at the Lighting Research Centre in Troy, New York (Figure 2). Note the small peak in polyethylene film near 270 nm corresponds with the UV-C range*. The solar UV-B transmittance of the plastic film was also tested in the field and was 80% for the F-Clean Clear, 17% for the F-Clean Gruv, and 1% for the standard polyethylene.

About UV radiation*

UV-A rays have the longest wavelengths, followed by UV-B, and UV-C rays which have the shortest wavelengths. While UV-A and UV-B rays are transmitted through the atmosphere, all UV-C and some UV-B rays are absorbed by the Earth's ozone layer. So, most of the UV rays that reach the Earth's surface are UV-A with a small amount of UV-B. The only way that plants can be exposed to UV-C radiation is from an artificial light source.

Figure 1. Small tunnels constructed to compare the different films with open-field plants. A randomised block layout with four replications of each treatment and 16 plants in each replicate was used in the experiment (only part of the experiment is pictured here). Photo credit: Natalia Peres, University of Florida Gulf Coast Research and Education Centre

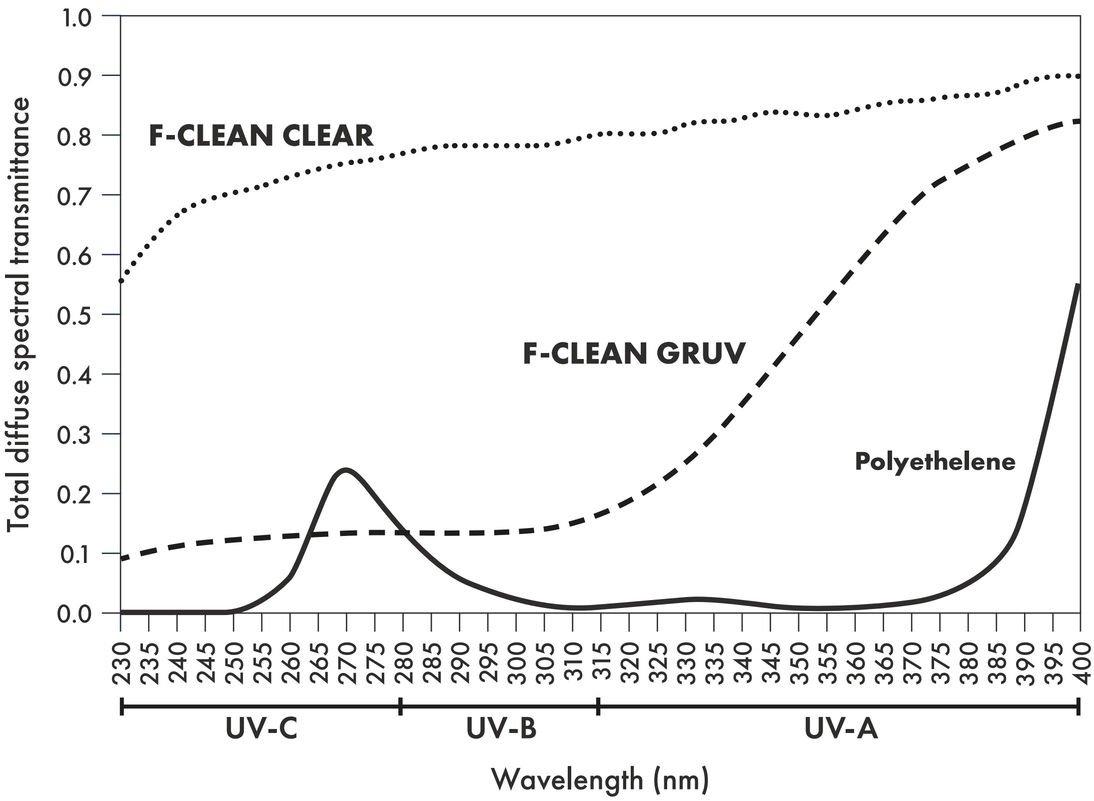

Figure 2. Total diffuse spectral transmittance for each film under laboratory-applied UV

Temperature and relative humidity data was collected for each treatment to compare conditions under the different plastic films and in the open-field.

Over the season, temperature differences between all treatments were minor and differences between humidity readings under the different film types was negligible.

Table 1 shows daily average temperature and humidity recordings for each of the treatments over the second year of the trial.

Fruit disease incidence and marketable yield were measured over the two growing seasons to compare the treatments (Figure 3).

Key results

- In both seasons, the incidence of powdery mildew on fruit was inversely related to the UV transmissibility of the plastic film.
- Marketable yield was also consistently higher in the open-field and F-Clean Clear plastic film compared with the standard polyethylene film.
- The F-Clean Clear plastic film provided an increase in marketable yield when compared to the polyethylene film of approximately 69% in the first year and 21% in the second year.

Table 1. Daily humidity and temperature averages in the different treatments shown with the solar UV-B transmittance of each plastic film.

	Polyethylene	F-Clean Gruv	F-Clean Clear	Open-field
Solar UV-B transmittance (%)	1	17	80	–
Humidity (%)	76.5	75.9	76.4	80
Temperature °C	20.5	20.4	20.8	19.4

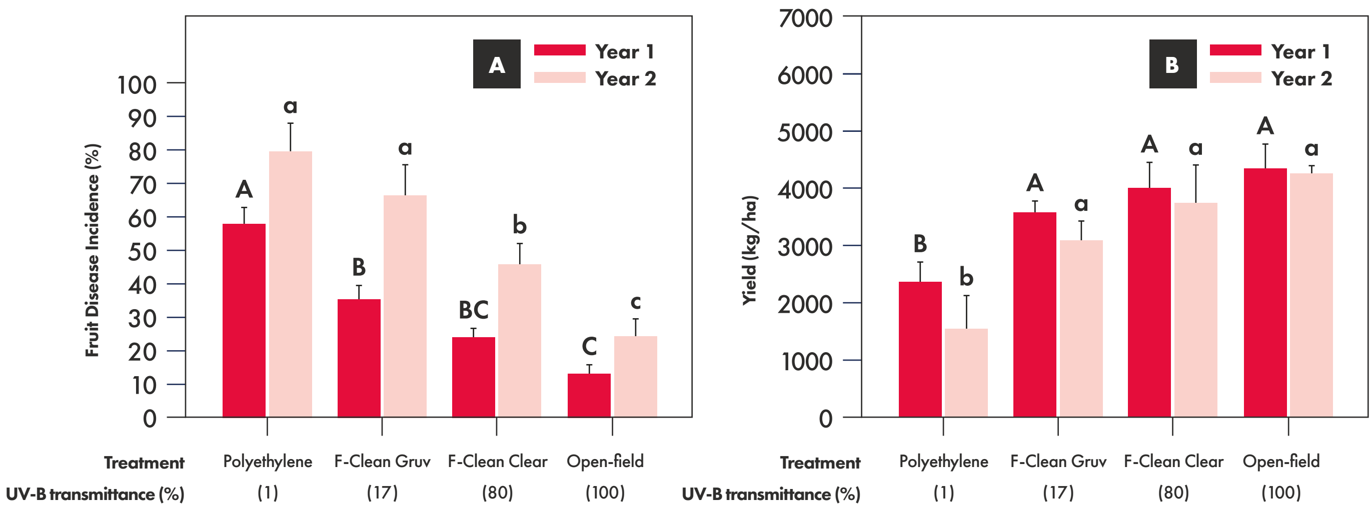

Figure 3. Effect of plastic film UV-B transmission on A, the incidence of powdery mildew on fruit and B, marketable yield. Columns with the same letter within the same growing season do not differ significantly.

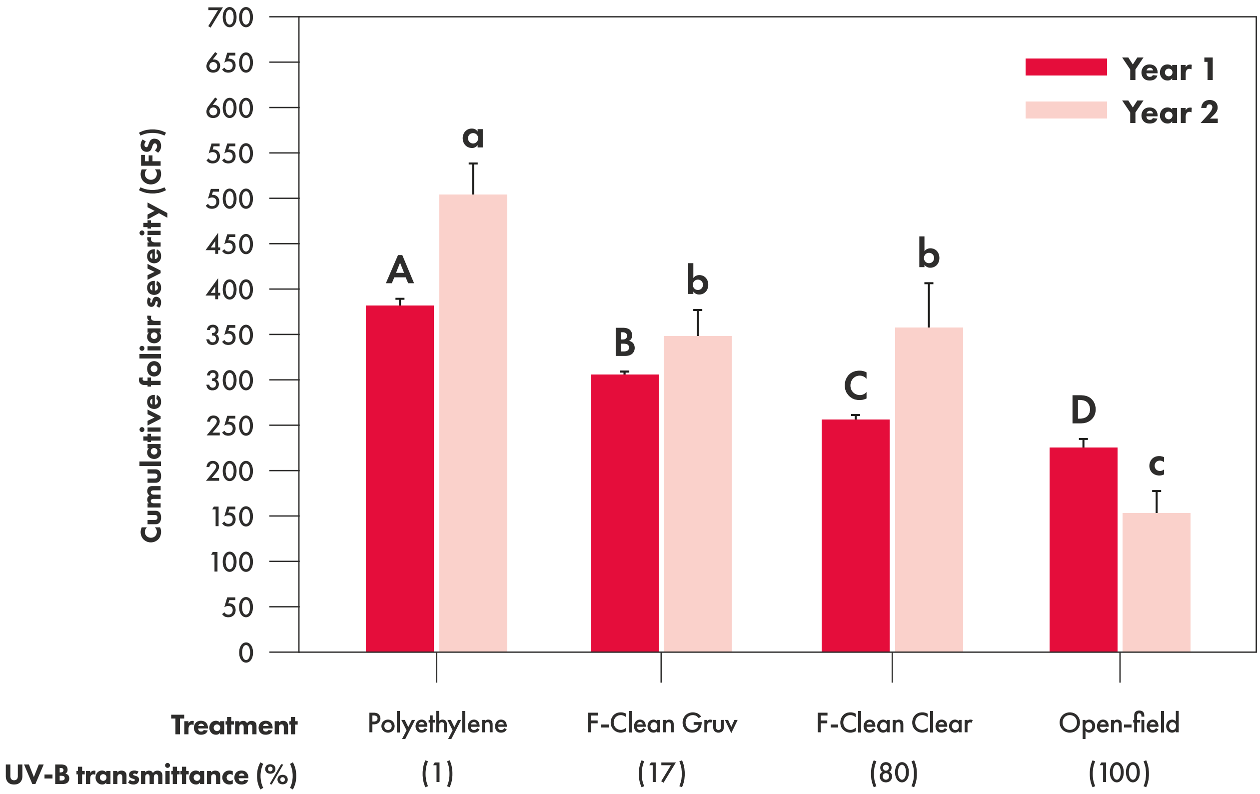

Figure 4. Cumulative foliar severity of powdery mildew. Columns with the same letter within the same growing season do not differ significantly.

Cumulative foliar disease severity across the treatments was also measured (Figure 4). Powdery mildew severity was lowest in the open-field and highest in the polyethylene film across all treatments for both seasons.

Both the F-Clean Clear and F-Clean Gruv resulted in significantly lower cumulative foliar severity in each season compared with polyethylene film. The F-Clean Clear provided a significant reduction in cumulative foliar disease in comparison with F-Clean Gruv in the first season but not in the second.

In the first growing season, at the peak of foliar disease severity (73 days after planting), the F-Clean Clear and the open-field treatments were not different and had significantly lower disease than the F-Clean Gruv and polyethylene plastic films.

In the second growing season, at the peak of foliar disease severity (71 days after planting), disease in the open-field treatment was significantly lower than all the plastic film treatments, however the F-Clean Clear treatment had 30% less disease compared to the polyethylene treatment.

Conclusions

Results of this research indicate that the exclusion of UV radiation by certain plastics is a major factor in disease development in protected cropping systems. Temperature and relative humidity often remained within the optimal range for strawberry powdery mildew development in both the open and protected system treatments and there were negligible differences in temperature and relative humidity between the plastic types (see the original paper for full details). It may therefore be concluded that exclusion of solar UV radiation is a principal factor in contributing to higher disease severity.

The magnitude of treatment effects in this study were substantial. Disease severity for crops covered with film transmitting 80% of solar UV-B was significantly lower (up to 3.3 times lower) than the UV-blocking film types. Marketable yields were also significantly higher under the UV transmitting films compared to the polyethylene. These findings may provide valuable guidance for selection of plastics and calibration of disease prediction models worldwide.

For more information or to access a copy of the full article used in this summary, contact:
Natalia Peres | nperes@ufl.edu