Novel cultural management techniques for Japanese beetle and spotted wing drosophila (SWD) in high tunnel raspberries.

Maria Cramer, Kathy Demchak, Richard Marini, and Tracy Leskey

This research was conducted at Penn State's High Tunnel Research and Education facility as part of the Specialty Crop Research Initiative project "Improving the Protected Culture Environment for Berry Crops." In this part of the project we focused on pest management; how qualities of plastic films can impact pest presence, and how cultural techniques such as harvest frequency and use of attracticidal spheres interacted with plastic type to affect SWD infestation.

The effects of UV-blocking plastic films on insects.

Plastic films that have different light-transmittance properties can affect plants and pests. Ultraviolet (UV) light is important for insect navigation, so plastics that block UV light may interfere with their movement. Past studies with greenhouses found that films that block UV-A light can reduce whiteflies, thrips, and aphids. UV-A light was found to trigger dispersal and without it some insects may not spread and cause damage. In 2016 and 2017 we investigated whether different plastics affected populations of Japanese beetles and SWD.

Types of plastics we investigated.

We looked at plastics that transmitted different amounts of the UV-spectrum. UV-light is light that we can't see, with shorter wavelengths than "visible light", the range used for photosynthesis. However, insects see and use UV light in the UV-A range (the part of UV closer to visible). UV-B light is important for plants and fungi but is not the part of UV that affects insects. All of our plastics blocked some amount of UV-A, ranging from 26% to 93%.

Effects on Japanese beetles.

We found that plastics that blocked more UV-A light did reduce numbers of Japanese beetles on the plants. Our experimental high tunnel film that blocked the most UV-A ("UVO") had 75-94% fewer beetles compared to Tufflite IV. In these tunnels Japanese beetles were extremely scarce and caused minimal damage while being removed every 4-5 days by hand. All of the plastic films reduced Japanese beetles compared to uncovered raspberries (at the minimum, reducing them 44%). Japanese beetles are known for being especially dependent on bright sunlight in order to fly. They tend to feed on leaves that are in direct sunlight, and usually are most active on sunny days. Light intensity is important for host selection, and our research suggests that one aspect of that is the amount of UV-A light present. It is likely that the reason for this is the ability to navigate to the host.

While the most UV-blocking plastic used in this research is not commercially-available, one of our partially-blocking plastics is (Ginegar SunSaver). Further, any tunnel is better than field production. We also found that the commercially-available "Kool Lite +" plastic does not decrease Japanese beetles more than "Tufflite IV."

Effects on SWD.

We found that SWD tended to be more abundant in field plantings than in the tunnels in 2016 and more abundant in the tunnels than in the field in 2017. This could have been due to a number of factors: temperatures were generally higher in 2016, and the high tunnels may have been too hot for SWD. SWD have a developmental threshold around 86 °F, so with higher temperatures the tunnels were probably too hot for them for longer periods. They're still present in tunnels because they "hunker down" in lower portions of the canopy to avoid the heat, but their development is favored by cooler temperatures. They also may have been more abundant in the tunnels in 2017 because fruit yields were much higher in the tunnels. The abundance of fruit may have attracted more of them. Also, the plants in the tunnels were very large and provided a humid, shady environment which SWD prefers.

The different plastics didn't affect the numbers of SWD in the tunnels, although there was a trend of the most UV-blocking plastic having the lowest numbers in 2016, but the highest in 2017. It isn't clear from this whether UV-blocking plastic is actually changing SWD preference for certain tunnels, but it seems unlikely since the trends were different in the two years.

Based off of these results, it appears that high tunnels can have lower SWD numbers than in the field, but the tunnels need to be carefully managed for sanitation. Pruning out excess growth may help, and all ripe and overripe fruit should be removed quickly. The benefits from growing in tunnels might depend high temperatures as well.

Combining UV-blocking plastic, attracticidal sphere, and harvest interval for controlling spotted wing drosophila in high tunnels.

There are a number of control approaches to SWD that are less disruptive than spraying insecticides, but they don't provide complete control on their own. We initially hypothesized that UV-blocking plastics might be such a control and that they could be combined with other partial controls to eliminate SWD infestation without sprays.

Attracticidal spheres.

Attracticidal spheres are a technology being developed by the USDA for SWD. They are round spheres, like those used as sticky spheres for apple maggot, with a cap made of wax, sugar, and a pesticide. When rain wets the wax cap, the sugar melts, coating the sphere and carrying the pesticides. SWD is attracted to the shape and color of the sphere and when the flies land they feed on the sugar and are poisoned. Spheres have been effective in field raspberries, but we wondered whether they would work in high tunnels without rainfall. A drawback to the spheres is that they are still in development and aren't currently available. They also are being developed with the pesticide Delegate and are unlikely to be available with an organic active ingredient.

Harvest interval.

Shortened harvest intervals have also reduced SWD infestation. At the research farm we harvest three times per week, but other studies and many growers harvest every other day or daily to reduce the amount of time that SWD can lay eggs in the fruit. We wondered if the combining daily harvest with the other treatments might bring infestation to a tolerable level.

Impact on marketable fruit.

Our proportion of marketable fruit was significantly higher (16-32%) when fruit were harvested daily. Spheres and the type of plastic used didn't impact the proportion of marketable fruit. Daily harvest probably increased the proportion of marketable fruit because less fruit was infested. Most of the fruit we considered unmarketable was the characteristic "melting", overly soft fruit associated with SWD infestation, but also included fruit that was simply missed in an earlier harvest, affected by mold, or that was considered too small, crumbly, or misshapen.

Impact on infestation.

We found that using spheres and harvesting daily consistently decreased the amount of fruit that was infested. Fruit harvested daily tended to be about 28% less infested. Despite only extracting larvae from marketable fruit, more larvae were present in fruit picked three times a week, even without outward signs of infestation.

Using spheres also decreased infestation from 31-50%. Without spheres we had 50-64% infestation of the fruit, and with spheres it was 25-46%. This showed that the spheres do work in the tunnels. Our procedure of initially spraying them with a spray bottle of water, and then spraying them more on hot, dry days seemed to be sufficient. We also found that during rain or particularly humid and overcast weather the spheres were kept wet by moisture in the air and were even dripping sometimes. The spheres had some impact on non-target pests. We frequently saw other flies, and occasionally lady beetles and moths feeding on or poisoned by the spheres. It is likely, however, that the impact of the spheres was less significant than applying a pesticide spray to the entire planting.

Plastic had mixed results. In some cases we found less infestation under the UVT plastic that transmitted UV-light, but we also found higher numbers of adult SWD under it. When we investigated how infested the unmarketable fruit was, we found that UVT plastic again had lower infestation rates (about 50% lower). Although UVT plastic seemed to have more adult SWD than UVO, it appears that there may be less oviposition under UVT. This may mean that SWD not only don't need UV-light to navigate, but that they may prefer to avoid it for activities like oviposition. Although it's hard to make a conclusion from these results, it seems likely that the standard plastics in use in our area are as good as any for SWD control.

Impact of time.

We found that infestation decreased over time. We repeated the experiment twice, and both times infestation started off high and then fell. This was true with all of our treatments, which may have been a "spillover effect," with one treatment decreasing SWD in treatments nearby. Another reason why infestation might have decreased was that during our experiments we harvested more regularly and removed all fallen fruit. Our heightened level of sanitation probably decreased infestation. This is encouraging, because it suggests that if treatments and sanitation are maintained throughout the season, SWD numbers and infestation can be kept lower.

More information on plastics, sources, and this research can be found on Tunnelberries.org

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Biography: Maria Cramer is currently a technician in the Hamby Lab at the University of Maryland's Entomology Department working with SWD and grain pests, and her interest is in IPM techniques. She recently completed her M.S. at Penn State in Horticulture with co-advisors Kathy Demchak and Rich Marini. She completed her B.S. in Horticulture at Delaware Valley University. She's from Snyder County, PA, where she worked as a State Apiary inspector for 3 years. She has also worked with a variety of tree and small fruit crops as an employee at Solebury Orchards and Northstar Orchard.