Effects of Low-Tunnel Plastic Type on Organic Production of Day-Neutral Strawberries

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Background

The modern cultivated strawberry *Fragaria x ananassa* is among the top five fruits produced in the United States. Since 1980, strawberry acreage has increased from roughly 36 to 58 thousand (USDA Economic Research Service, 2016). In 2015, utilized production was valued at 2.2 billion dollars, making strawberries the third most valuable non-citrus fruit crop in the United States, behind apples and grapes (USDA National Agricultural Statistics Service, 2016).

There are several kinds of strawberry cultivars, categorized based on their flowering and fruiting habits. "June bearers" produce fruit for a few weeks in early summer and are typically grown in a perennial system with matted rows (Cross et al., 2001; Hoover et al., 2014). "Day-neutral" cultivars produce fruit continuously under the right conditions for months at a time. Though strawberries as a whole can tolerate a wide range of growing conditions, day-neutral cultivars are not as cold hardy as June bearing cultivars. Thus in northern states, the majority of commercial strawberry production has been limited to June bearers (Hoover et al., 2014; Wold & Hutchison, 2003). However, with the development of "protected culture" strawberry production systems, in which strawberries are grown on raised beds sheltered under plastic low tunnels, some of the newer day-neutral cultivars are doing very well as annuals, even in colder states (Cross et al., 2001; Hoover et al., 2014).

The use of low tunnels to create a suitable microclimate for day-neutral strawberries in regions where climate would otherwise limit production is a relatively new technique (Hoover et al., 2014), and many avenues for experimentation within the system remain unexplored. The plastic films used for construction of the low tunnels can be made to alter light transmission in specific ways. Some plastic films are designed to act as photo-selective barriers, blocking UV light while still allowing adequate transmission of visible light in the range necessary for photosynthesis: photosynthetically active radiation (PAR) (Costa et al., 2002). By optimizing the wavelengths of light that reach the plants, fruit quality may be improved and occurrence of certain fungal diseases may be reduced (Hoover et al., 2014).

Additionally, there may be potential for disrupting movements and activity of insect pests under tunnels (Díaz et al., 2006; Paul et al., 2012). A study comparing pests on lettuce plants under UV-blocking and UV-transmitting films found that the UV-blocking film reduced the immigration, population density and spread of the aphid species *Macrosiphum euphorbiae* and *Acyrthosiphon lactucae* among the lettuce plants. However, net potential for use of UV-blocking films in insect pest management is still uncertain. The same study found that the UV-blocking film did not reduce infestation by the greenhouse whitefly *Trialeurodes vaporariorum* and populations of thrips reached comparable levels under both types of films by harvest (Díaz et al., 2006).

Damage caused by insect pests and disease can reduce the marketability of strawberry fruit, as well as fresh storage potential. There are numerous products available for the control and

mitigation of pests and disease, but many of these are not permitted in organic production. The majority of strawberry acreage in the U.S. is non-organic, but consumer concern over pesticide residues on conventionally grown fruits and vegetables has likely contributed to the increasing demand for organic strawberries (Hoover et al., 2014). Successful pest management in organic systems often depends on having a combination of strategies and techniques to employ. A look at how different plastic films for low tunnels affects presence of key strawberry pests could help organic strawberry growers who are interested in using the protected culture production system for day-neutral cultivars select the best products for their operations.

With funding from the USDA, a team of researchers from multiple universities are partnering on a project titled "Optimizing Protected Culture Environments for Berry Crops." The project includes work on both raspberries and strawberries in high and low tunnel systems, as well as research into the recyclability of different plastic materials. Within this project, my focus is on organic production of day-neutral strawberry cultivars using low tunnels. The objectives of my study are to evaluate the effects different plastic types have on strawberry fruit yield and quality, insect pest presence and management, and microclimate factors.

Methods

In May of 2016, twelve strawberry plots, each with roughly 35 feet of planted length, were established on certified organic land at the University of Minnesota's St. Paul campus. Plots had one of three main treatments applied in a randomized design: covering with a UV-transparent plastic, with a UV-blocking plastic, or with no plastic at all (control). In total, there were 4 reps of each treatment. Sub-plot treatments of three different organically approved biopesticides (plus water, as control) were also applied twice during the season.

Each plot consisted of a raised bed of strawberries on plastic mulch with landscape fabric between beds. A white-on-black plastic mulch was selected for its advantage of warming the soil underneath while reflecting light on top to keep the temperature under tunnels cooler (Hoover et al., 2014). The cultivar 'Albion' was chosen based on previous success in University of Minnesota field trials. An Onset brand Weather Station data logger was installed in the field and connected to sensors for temperature, humidity, and light.

At each harvest, all fully ripe fruit (marketable and unmarketable) was taken from plants, weighed and recorded as yield. Additional data was gathered on marketability of fruit, brix (a measure of soluble solids content), insect pest presence, and pesticide residues. Roughly once per month, a sample from each plastic tunnel was removed and analyzed with a NanoDrop brand spectrophotometer to determine how light transmission at different wavelengths through the plastics changed from month to month.

References

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