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A New Invasive Problem for Cucurbits in Our Area

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Sometime in early September I got a call from Bob Rouse asking me to look at a pumpkin field located at the Western Maryland REC in Keedysville. Something about the color of the yellow leaves had Bob worried that it could be something odd. By the time I got to the field the entire field had a yellow caste to it (fig. 1). However there were particular plants that had an odd yellow color to them in which some of the leaves were dead but there was little wilting (fig. 2). When I cut a cross section at the base of the stem on these particular plants the interior of the stem showed a distinct yellow-brown coloration of the phloem (fig. 3). This honey-colored phloem is one of the characteristics of a disease called Cucurbit yellow vine decline or disease (CYVD). The bacteria *Serratia marcescens*, the causal agent of CYVD, was recovered from the phloem of symptomatic plants.

Fig. 1 Pumpkin field in mid-September with many yellowing plants.

Fig. 2 Odd yellow-colored pumpkin plants that did not wilt.

Cucurbit yellow vine disease was first found in squash and pumpkins in Texas and Oklahoma in 1988. Three years later it was causing large scale losses of watermelons and cantaloupe in some areas of these two states. The disease has since been found in Arkansas, Colorado, Kansas, Nebraska, Missouri, Massachusetts, and Connecticut (odd sort of spread it seems). In areas where it has been found the disease incidence is often spotty within a field, and within an area. Oftentimes fields adjacent to the infected field will show no symptoms. At times the disease is completely absent in some years or could cause widespread symptoms in cucurbit fields in other years.

Fig. 3 Cross-section of the stem of an oddly yellow plant showing the honey-colored phloem (arrows) characteristic of Cucurbit yellow vine disease.

(iii) Oxalate: OA levels were significantly different among lima-, soy-, and common beans (P=0.012) and among the isolates (P=0.04). However, there was no significant difference among cultivars.
Spearman Correlation Coefficients showed there was significant (P<0.0001) but weak correlation (R=0.274) between aggressiveness/lesion size and OA production on the three crops. The above results indicate that OA may not be the sole factor that plays a role in aggressiveness of *S. sclerotiorum*. Alternatively it may indicate that the role of OA in lesion production is more complex than previously thought.

(iiii) Endura spray timing: There were significant differences (P<0.0001) between Endura application timings on disease incidence (DI) and disease severity (DS). Both DI and DS were also significantly different across years, but no significant variations were observed between locations. Disease levels were generally lowest when fungicide applications occurred at early flowering stage compared to later application timings. Yield of lima bean was significantly affected by year and location, but not by Endura spray timing.

Figure 4: Differences in disease incidence and severity on lima bean at different spray timings; (a) late (two weeks from the first spray) spray; (b) Early spray (at 100 % flowering stage); and (c) Non-treated plants. Lynn Rd, Lewes, DE grower field on October 2017.

Cultural Controls for SWD Management in Blueberries and Raspberries

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Spotted wing drosophila (SWD), a native to Southeast Asia, has become a major insect pest of small fruits, especially blackberries, blueberries, and raspberries in the U.S. Spotted wing drosophila can become stressed under high temperature and low humidity conditions. When stressed, SWD develop more slowly, don't reproduce as well, and may die. Cultural controls aim to manipulate the environment to make conditions more unfavorable for pests and are an important component of the Integrated Pest Management (IPM) toolbox. We are exploring cultural management practices, such as **mulches and pruning** treatments, which can impact the environmental suitability of crops for SWD development and survival. In a study comparing woodchip mulch to a black fabric weedmat in blueberries, we found that the surfaces of the mulches are hot for longer than below the mulch, and the **fabric creates a warmer environment** at some sites. SWD placed in the environment survive better below the mulches compared to above the mulches. We also found that pruning could be a viable way to reduce SWD infestation, but it is **difficult to** sufficiently **prune** plants enough **to change environmental conditions while maintaining yield**.

Impact of Mulches on Survival of Spotted Wing Drosophila

Female SWD lay eggs in ripening fruits. Larvae develop within the fruit and may either pupate in the fruit or drop to the soil below the plant. In 2016 and 2017 at the Western Maryland Research and Education Center (WMREC), Keedysville, MD and the Wye Research and Education Center (WYEREC), Queenstown, MD, we evaluated the impact of mulches on SWD development at different life stages. Two mulching treatments were used: bare woodchip mulch (mulch) and woven black weed fabric over woodchip mulch (fabric). Throughout the blueberry fruiting season temperature data loggers were deployed above the mulch as well as ~1" below the mulch of each treatment plant. Temperatures were recorded every 20 minutes. Temperatures above the mulch were highly variable, often approaching or exceeding 120°F. Mulch treatments impacted the regularity at which temperatures exceed 87°F, the temperature where SWD starts to exhibit heat stress.

Environmental conditions due to mulches impact SWD survival at different developmental stages. Laboratory infested organic blueberries were sorted into small groups with equal number of eggs (about 40 or 50, as available) and bagged. Concurrently, early-stage pupae from the laboratory fly colony were collected, adhered to cards, enclosed in wire mesh cages, and bagged. Bags were placed either above or below the mulch treatments at each site, and left for one week. The fruit and pupae were returned to the laboratory and held an additional two weeks in the lab to allow for surviving adult emergence, then adults were counted.

Figure 1. Examples of treatments deployed

Figure 2. Condition of berries after treatments.

Examples of treatments are shown in Figure 1. SWD survived better in the cooler climate below the mulch at both sites (Table 1 and 2). At WYREC, the fabric was hot longer than the woodchip mulch and SWD survived best below the woodchip mulch (Table 1). In most replicates of the two-year study, zero or very few individuals survived above either type of mulch. Temperature, humidity, and SWD life stage likely all play a role in these responses. Conditions of berries after one week of treatment are shown in Figure 2. Those held above the fabric mulch are dry and shriveled, whereas those below the woodchip mulch are visibly more favorable for survival.

Table 1 WYEREC mulching study, 2016-2017

Treatment	2016 Berry Survival N=2	2017 Berry Survival N=2	2016 Pupa Survival N=2	2017 Pupa Survival N=2	2016 Hours >87 °F N=2	2017 Hours > 87 °F N=2
Lab Control*	66%	73%	88%	73%	0	0
Fabric Above	0%	3%	5%	3%	50	28
Fabric Below	5%	1%	10%	1%	31	16
Mulch Above	0%	7%	17%	7%	46	21
Mulch Below	35%	38%	66%	38%	19	10

Table 2 WMREC mulching study, 2016-2017

Treatment	2016 Berry Survival N=2	2017 Berry Survival N=3	2016 Pupa Survival N=2	2017 Pupa Survival N=3	2016 Hours >87 °F N=2	2017 Hours > 87 °F N=3
Lab Control*	73%	56%	91%	69%	0	0
Fabric Above	0%	0%	2%	0%	46	41
Fabric Below	0%	13%	8%	14%	39	36
Mulch Above	0%	0%	9%	0%	46	41
Mulch Below	0%	16%	4%	24%	39	33

**Laboratory controls demonstrate the ability of SWD to develop and survive into adulthood in experimental containers (mesh bag/pupal card) under ideal environmental conditions.*

In summary, the black fabric weed mat tends to sustain hotter temperatures longer at some sites, and additionally, it acts as barrier between the plant and the mulch. Whether SWD pupates within the fruit or falls to the ground to complete development, it is likely easier for them to get below the mulch, where conditions are more favorable, when plants are mulched with bare woodchips. The fabric weed mat may be beneficial for SWD management in blueberries.

Effects of Pruning on Climate and SWD Infestation

In 2016 and 2017, we conducted a pruning study at two private organic blueberry farms in Carroll County and Baltimore County, MD, as well as in fall bearing raspberries at WMREC and WYEREC. Similar to mulching, pruning is a cultural control tactic that can be used to manipulate the environment and impact SWD. For example, high pruning would result in lower-density foliage (foliage density indicated by shade of green below), and therefore potentially higher temperatures and lower relative humidity throughout the canopy. Each year, during the dormancy period, blueberry plants were pruned in three treatments: high prune (25% more than grower's standard), grower's standard, and low prune (25% less than grower's standard) (Figure 3). Fall bearing primocane raspberries were pruned just prior to fruiting in three treatments: no prune (grower's standard), medium prune, and high prune. Throughout the growing season, data loggers recorded temperature and relative humidity in the interior and exterior of the plant. Fruit quality measures, yield, and natural infestation were evaluated weekly. We included 2016 and 2017 blueberry data. Raspberry data for 2016 is presented here; 2017 data is yet to be analyzed.

Figure 3. Pruning regimes in blueberries. The green bar represents foliage density in each treatment.

In blueberries, overall, we were not able to manipulate the temperature in the canopy significantly, although at Site,1 pruning did impact the relative humidity. At that site, relative humidity was sustained below 70%, the threshold at which SWD start to demonstrate stress, for significantly longer in the high prune/less dense treatment compared to the low prune/high density treatment. Pruning can have an effect on yield, however, and did significantly impact total yield at Site 2 in 2016 and 2017. In raspberries in 2016, pruning impacted the number of hours the temperature exceeded 87°F at WMREC, with warmest temperatures in the high and medium prune treatments. At WYEREC treatments did not impact temperatures. Relative humidity was not affected by pruning treatment at either site.

Table 3 Mean hours of unfavorable conditions per week per plant in blueberries; Temperature>87°F, Relative Humidity<70%

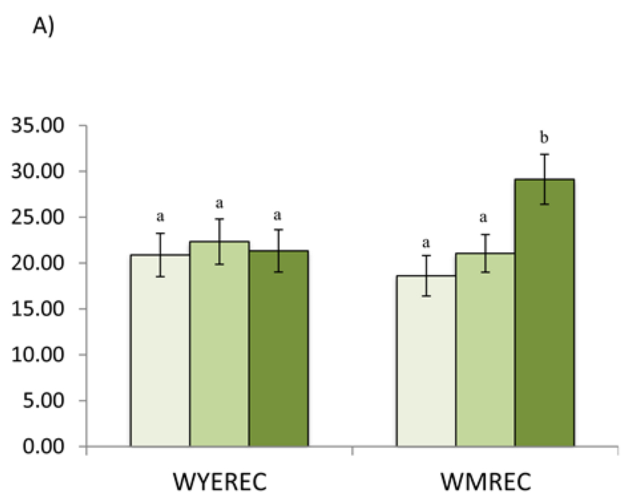
	Site 1: 2016		Site 2: 2016		Site 1: 2017		Site 2: 2017	
	Temp>87	RH<70%	Temp>87	RH<70%	Temp>87	RH<70%	Temp>87	RH<70%
High Prune	13.0±1.4	25.0±1.3	10.4±1.2	28.0±1.3	9.7±1.0	23.3±1.8	12.7±1.3	29.2±2.2
Med. Prune	11.4±1.3	25.3±1.4	10.4±1.2	28.1±1.3	10.0±1.4	23.7±1.9	13.3±1.3	29.0±2.3
Low Prune	11.9±1.4	26.3±1.3	10.2±1.3	28.4±1.7	11.4±1.2	25.6±1.8	12.8±1.3	31.4±2.4

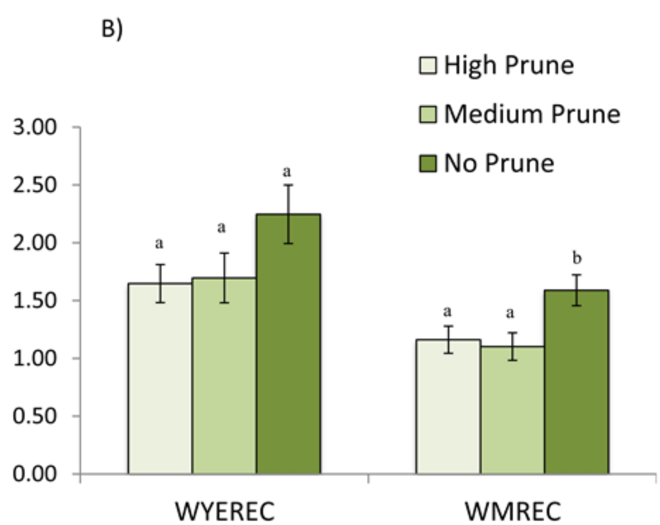
Table 4 Mean hours of unfavorable conditions per 4 weeks per plant in raspberries (2016); Temperature>87°F, Relative Humidity<70%

	WYEREC: 2016		WMREC: 2016	
	Temp>87	RH<70%	Temp>87	RH<70%
High Prune	47.8±12.1	115.6±5.5	39.0±8.1	124.1±9.6
Med. Prune	48.1±10.6	112.5±4.9	40.0±8.1	113.9±2.5
Low Prune	48.7±10.9	113.6±5.2	34.8±7.5	109.9±2.64

In raspberries in 2016, pruning did impact the average larvae per berry at WMREC, with more larvae in the denser and cooler no-prune treatment than the medium or high prune treatments (Figure 4). At WYEREC, pruning did not have a significant impact on infestation, but the same trend was observed, with the highest infestation per berry in the no pruning treatment. Pruning treatment did not have an effect on natural infestation in blueberries. Although, especially in 2016, pest pressure was quite low. In blueberries in 2017, we did see significantly more SWD larvae per berry in the interior of the canopy compared to the exterior when treatments were pooled. In dense foliage, it is challenging to reach the interior of the canopy with sprays. The higher SWD density within the interior of the canopy suggests that if we can manipulate the climatic conditions and improve spray coverage in this area with pruning, we may be able to impact infestation.

Figure 4 Effects of pruning on yield and infestation in raspberries, 2016. A) Mean weekly total yield by site. B) Mean larvae per berry by site. Letters indicate differences by treatment.





In both raspberries and blueberries, pruning had a measurable impact on the environmental conditions within the canopy, and in raspberries the pruning manipulation resulted in reduced infestation at one site. A measure of canopy density demonstrated that at WMREC, our pruning treatment altered the canopy density significantly, while at WYEREC, the manipulation had less of an impact on the actual foliar density of the plants. The canopy density was also significantly different at blueberry Site 2, whereas we did not impact the foliar density significantly at blueberry Site 1. Therefore, we may only observe an impact on SWD infestation with significant thinning of the canopy. That being said, pruning can impact overall yield. At blueberry Site 2, as well as in WMREC raspberries, the treatment with the highest foliage density did produce more overall yield. In WMREC raspberries this also corresponded with the highest larval infestation per berry. Future analyses will consider the impact on marketable yield compared to cull in each crop and each treatment to determine whether higher yields equate to higher quality yields in the high-density, no prune treatments.

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Current Management Strategies for Managing Ear Invading Caterpillars of Sweet Corn

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Corn earworm is the primary ear invader of sweet corn, followed by European corn borer, sap beetles and fall armyworm. Infestation levels in Maryland vary with the year, time of season, and farm location. For instance, corn earworm successfully overwinters in the warmer counties of the state, allowing population built up to start earlier in the season. However, a major source of late season infestations of earworms and fall armyworms (does not overwinter in Maryland) results from migrant moths carried northward on storm fronts into the region during mid to late summer. Population pressure is generally higher on farms on the Eastern