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Efficacy & Economics of Managing Cucumber Downy Mildew with Resistant Varieties and/or Fungicides

Research Report, 2016 & 2017

Many growers remember the "good ole days" when you could pick cucumbers into the fall and even until the first frost. Nowadays cucumber plants go down much earlier, around mid-August to early-September, when the leaves suddenly turn yellow, then brown, and shrivel up. These are telltale symptoms (along with a furry or crusty dark brown to gray sporulation on the undersides of the leaves) of cucurbit downy mildew, a disease caused by the oomycecte *Pseudoperonospora cubensis*. The disease affects all cucurbit crops and can cause sudden and complete death of foliage, effectively ending the cucumber season. This pathogen is an obligate parasite, meaning it needs a living host to survive. Thus, the disease overwinters in FL where cucumbers are grown throughout the winter, and works its way north as the growing season progresses. There are several strains that affect different crops, but all strains affect cucumber, making them the most susceptible crop to the disease. The disease was controlled for decades because all cucumbers carried a resistance gene, but in 2004 the pathogen evolved and overcame that resistance and now there is a great effort to breed new varieties with alternative sources of disease resistance. Here at UMass we have been evaluating some of these new varieties to see how they hold up in MA, and looking at the economics of using host resistance and/or spraying fungicides (organic or conventional). For these trials we focused on slicing cucumbers but hope to continue looking at other types in the future.

Evaluating Resistant Cucumber Varieties. We compared 6-8 varieties in 2016 and 2017 with four replications of each variety organized in randomized complete blocks so that we could determine significant differences between varieties. We planted four-week-old seedling into black plastic mulch with drip irrigation during the last week of June and started harvesting on August 5 in 2016 and on July 25 in 2017. The growing seasons of these two years were very different, with 2016 being very hot and dry with low downy mildew pressure and 2017 being relatively cool and wet with high disease pressure. Additionally, in 2017, the pathogen arrived on August 1, two weeks earlier than in 2016. In 2016 we had an unexpected outbreak of watermelon mosaic virus which drastically reduced marketable yield of the susceptible control 'Straight 8', while other varieties were unaffected. We measured disease severity and marketable yield every week and summed them up over the season. Figure 1 shows the area under the disease progress curve (AUDPC—a higher number means more disease over time) and marketable yield per acre. Bristol, DMR401, and NY264 had among the lowest disease severity and the highest yields in both years. Diamondback, Python, and SV4719CS performed better than the susceptible control but not as well as the other resistant varieties. Green Bowl had terrible yields and therefore won't be commercialized.

Economics of Integrated Disease Management. In the second set of experiments, we investigated the economics of different management strategies, and compared one resistant and one susceptible variety under two fungicide spray programs, one organic and one conventional. We setup plots of susceptible (Straight8) or resistant (SV4719CS) cucumbers in randomized complete blocks and then applied one of the following spray treatments in a 5-7 day spray schedule once disease was confirmed in the area:

- Unsprayed
- Conventional Spray: Included a fungicide effective for powdery mildew (Torino, Procure, or Inspire Super) and a fungicide effective for downy mildew (Ranman or Tanos) in rotation and mixed with Bravo Weatherstick

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- Organic Spray: Oxidate alone for powdery mildew before the arrival of downy mildew, and copper (NuCop HB) alone once downy mildew arrived.

Table 1. Evaluating resistant cucumber varieties.

		Downy Mildew AUDPC[z]		Total Marketable Yield (lb/A)[y]		Last Harvest Date	
Cultivar	**Seed Supplier**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Straight Eight (Susceptible control)	Burpee	16.4 a	2418.8 a	18,391 d	8,826 cd	2-Sep	22-Aug
SV4719CS	Seminis	8.1 b	1345.0 b	28,826 c	15,522 abc	9-Sep	29-Aug
Green Bowl	Known-You	3.7 d	134.2 c	22,696 cd	5,522 d	13-Sep	22-Aug
Bristol	Seminis	7.1 bc	419.4 c	40,652 ab	17,348 ab	13-Sep	4-Sep
DMR401	Commonwealth Seeds	5.7 c	1249.4 b	32,435 bc	19,913 a	9-Sep	4-Sep
NY264	Commonwealth Seeds	0.6 e	175.9 c	53,217 a	17,261 ab	30-Sep	11-Sep
Diamondback	Seedway	na	1426.3 b	na	12,217 bcd	na	1-Sep
Python	Seedway	na	1391.3 b	na	14,957 abc	na	4-Sep
p-value		<0.0001	<0.0001	0.0005	0.0087	--	--

[z]Data were analyzed using a generalized linear model and means were separated using Tukey's HSD at alpha = 0.05. Numbers within each column which share the same letter are not significantly different from each other.

[y]Total yield was recorded twice weekly and is here summed across the whole season.

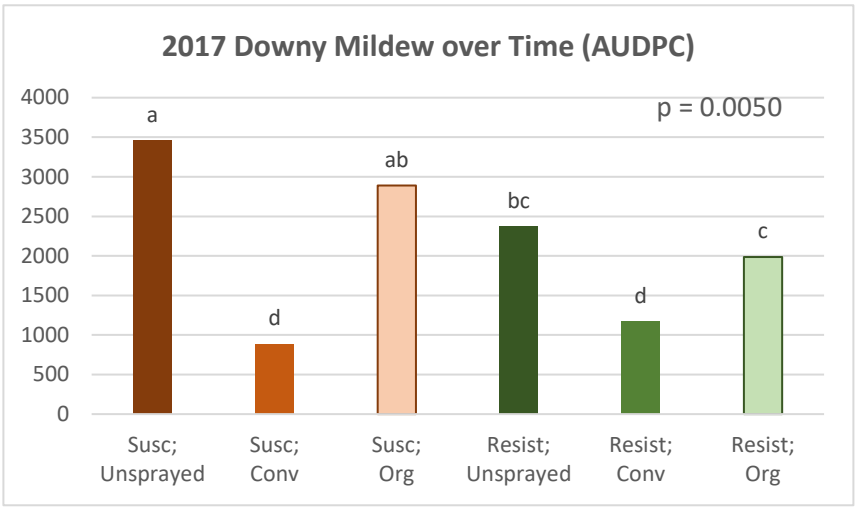

Figure 1. 2017 Downy mildew over time (AUDPC)

In 2016, we sprayed 6 times before the plants went down. In 2017, because of the earlier arrival of downy mildew, we sprayed 9 times. We rated disease severity and marketable yield. Our disease severity results were very consistent between the two years (results from 2017 are shown in Figure 2) and show that the conventional fungicides are the most effective tool in controlling downy mildew all season long, if you can spray every 5-7 days and have a good spray program with the right materials in rotation. Our data also shows that the resistant variety has significantly less disease than the susceptible variety, and that spraying copper does slow disease spread, especially in a drier year like 2016 when downy mildew came late.

When we look at the marketable yield data (Figures 2 and 3), the two years were not as consistent. In 2016, the resistant variety treatments yielded significantly higher than the susceptible varieties. This was

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due to a virus that affected the susceptible variety, Straight 8, and not the resistant variety, SV4719CS, drastically reducing marketable yield of Straight 8, and because the downy mildew pressure was low, so the fungicides didn't give much of an advantage to the sprayed plants. In 2017, under very high disease pressure, the conventional fungicides were very effective at controlling disease; the highest marketable yield was achieved by spraying the susceptible variety with a conventional program. The susceptible and resistant varieties had very different yield potentials – the susceptible Straight 8 had a very high yield potential compared to the resistant SV4719CS, which was not a prolific producer even under the best conditions. Looking at the yield of the resistant variety, it was fairly consistent year to year despite the very different conditions, and the fungicide treatments made no statistical difference in yield compared to the unsprayed treatment.

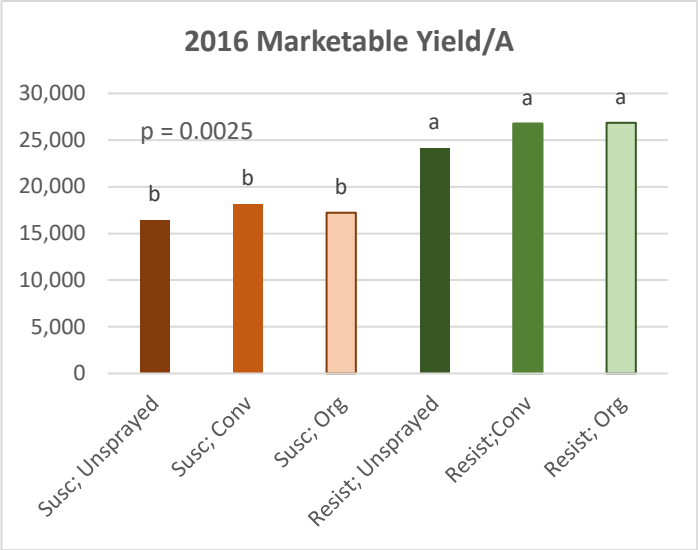

Figure 2. 2016 marketable yield per acre

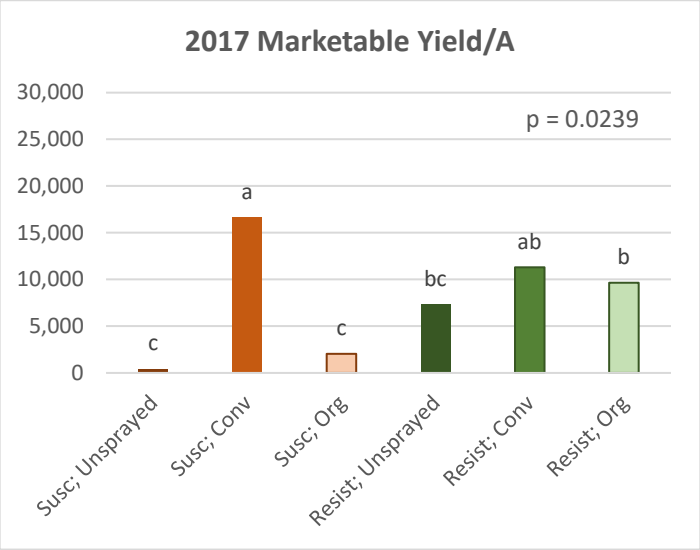

Figure 3. 2017 marketable yield per acre

When we looked at the profitability of the different management approaches, we found that some growers might find it is worthwhile to spray and get higher yields. If you don't have spray equipment, growing a resistant variety meant a profit margin of $13,861 for conventional cucumbers or $17, 326 for organic cucumbers. The profit margin was greatest on the resistant variety with an organic spray program, and with a conventional spray program on the susceptible variety (Fig. 5). We calculated the cost for the entire season of the materials we sprayed for each treatment ($400-$700 for the

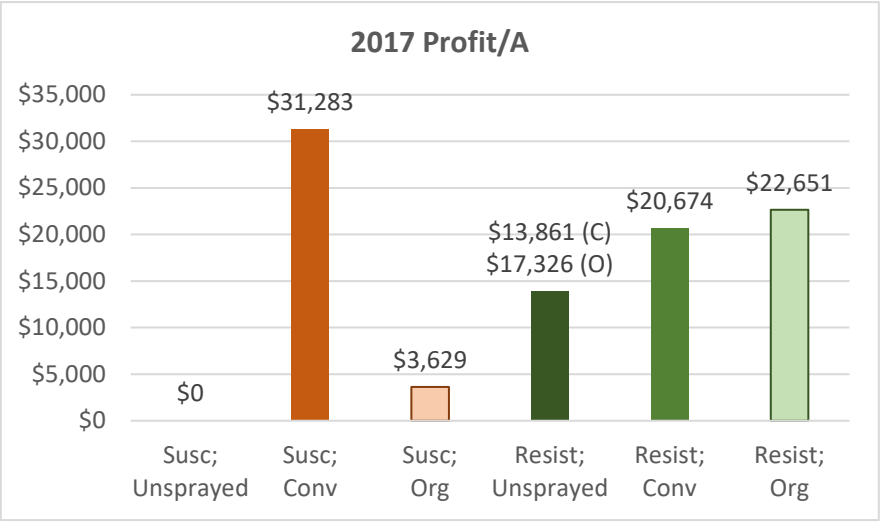

Figure 5. Profits are based on a conventional cucumber (C) price of $2/pound and organic cucumber (O) price of $2.50/pound.

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conventional sprays and $40 for organic), the labor ($24/hr), and the sprayer tractor time ($20/A) then subtracted that from the total sales assuming conventional cucumbers could be sold for $2/pound and organic cucumbers could be sold for $2.50/pound.

Some conclusions about different disease management approaches learned from this study are:

- **If you plan to use conventional fungicides, have a good rotation program for downy and powdery mildew, and can spray every 5-7 days, then you should pick a high-yielding variety, regardless of susceptibility.** Under these circumstances, we were able to harvest cucumbers until October 2nd.
- **However, if you can't spray diligently, resistant varieties offer a very consistent and economical alternative that you may not need to spray at all.** We picked our unsprayed resistant variety, SV4719CS, until September 15th—I wonder how late we could have harvested if instead we'd chosen NY264 or Bristol, knowing now that those have better resistance and yields?

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--Written by Susan B. Scheufele, UMass Extension Vegetable Program