53 Pickling Cucumber

Where: Gallery Overlook Room E & F
MI re-certification credits: 2 (1B, COMM CORE, PRIV CORE)
OH re-certification credits: 0.5 (presentations as marked)
CCA Credits: PM (1.5) CM (0.5)
Moderator: Ben Phillips, Michigan State University Extension

9:00 AM **The Last Word in Pickling Cucumber Weed Control**
- Bernard Zandstra, Michigan State University

9:15 AM **Managing Cucumber Diseases in 2019 (OH: 2C, 0.5 hr)**
- Mary Hausbeck, Michigan State University

9:40 AM **Enhancing Pollination in Cucumber Fields**
- Thomas Wood, Michigan State University

10:15 AM **Scouting Cucumber Fields with Drones**
- Ian MacRae, University Of Minnesota

10:40 AM **The FSMA Preventive Control Rule: Is this something I need to worry about?**
- Phil Tocco, Michigan State University Extension

11:00 AM **Session Ends**

Managing Cucumber Diseases in 2019

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Michigan State University, Department of Plant, Soil and Microbial Sciences

Cucurbit Downy Mildew (DM): In Michigan, DM causes leaf blighting and death of the foliage on cucumbers. Other susceptible crops include melon, squash, and pumpkin. The microorganism responsible for DM is *Pseudoperonospora cubensis*. The DM pathogen cannot overwinter in Michigan fields but can overwinter in greenhouses or production regions that do not experience a frost.

Certain fungicides that used to be effective are no longer working well in Michigan. If DM is not controlled, yield and quality suffer. Fungicides must be used before disease develops in the field and spore trapping is used in Michigan to detect DM sporangia in the air in the production areas (www.veggies.msu.edu/downy-mildew-news, www.downymildew.msu.edu).

Each year, extensive field studies are conducted at the MSU Plant Pathology Farm in Lansing, MI to compare fungicides applied alone (Trial 1), applied in fungicide programs (Trials 2,3) and applied in fungicide programs to susceptible and tolerant cucumber cultivars (Trial 4) for their ability to limit DM. Products that were tested in 2018 are listed in Table 1. DM was first observed on the MSU Plant Pathology Farm on 15 August on cucumber.

Table 1. List of fungicides tested in Michigan in 2018.

Product	Active ingredient	FRAC code[1]	Labeled
AVIV SC	*Bacillus subtilis*	44	yes
Bravo WeatherStik SC	chlorothalonil	M05	yes
Cabrio EG	pyraclostrobin	11	yes
Cueva SC	copper octanoate	M01	yes
Curzate DG	cymoxanil	27	yes
Double Nickel LC	*Bacillus amyloliquefaciens*	44	yes
Echo 720 SC	chlorothalonil	M05	yes
Elumin SC	ethaboxam	22	yes
Forum SC	dimethomorph	40	yes
Gavel DF	mancozeb/zoxamide	M03/22	yes
Koverall DG	mancozeb	M03	yes
Omega SC	fluazinam	29	yes
Orondis Opti A OD	oxathiapiprolin	49	yes
Orondis Opti SC	oxathiapiprolin/chlorothalonil	49/M05	yes
Presidio SC	fluopicolide	43	yes
Previcur Flex SL	propamocarb	28	yes
Priaxor SC	fluxapyroxad/pyraclostrobin	7/11	no
Ranman SC	cyazofamid	21	yes
Revus SC	mandipropamid	40	yes
Serenade ASO SC	*Bacillus subtilis*	44	yes
Stargus SC	*Bacillus amyloliquefaciens*	44	yes
Tanos DF	famoxadone/cymoxanil	11/27	yes
Timorex ACT SC	--	--	no
V-10365 SC	--	--	no
Zampro SC	ametoctradin/dimethomorph	45/40	yes
Zing! SC	zoxamide/chlorothalonil	22/M05	yes

[1]Numbers and letters are used to define the fungicide groups by their mode of action. M=multi-site inhibitors. Visit www.frac.info for more information about FRAC codes.

Treatments were arranged in a completely randomized block design with four replicates. Each treatment replicate consisted of a single 20-foot long row with a 3-foot buffer between treatments within the row. Foliar spray treatments were applied using a CO_2 backpack sprayer and a broadcast boom equipped with three XR8003 flat-fan nozzles spaced 18 inches apart and calibrated at 50 psi and delivering 50 gal/A. Foliar disease severity was evaluated as the percentage of foliage infected (0 to 100%). Fruit were harvested from the entire 20-foot plot and weighed. Data were analyzed using an analysis of variance (ANOVA), with means separation performed using Fisher's protected least significant difference (LSD) using the statistical software SAS v9.4.

Trial 1. Evaluation of single fungicides.

Cucumber 'Vlaspik' seeds were sown on 20 July. Foliar spray treatments were applied on 10, 16, 23 and 30 August; and 7, 14, and 22 September. Foliar infection was evaluated on 29 August; 3, 6, 16, 24 and 27 September. Fruits were harvested on 10, 14, 19 and 26 September.

Treatments of Bravo WeatherStik, Elumin, Gavel, Koverall, Omega, Orondis Opti, Previcur Flex, Ranman, and Zampro significantly limited DM on the last rating date of 27 September compared to the untreated control (Figure 1). The same treatments, with the addition of Tanos, produced significantly larger total yields than the untreated control. Previcur Flex provided a high level of foliar protection that was similar to Ranman and better than all other treatments included in this study. The best-yielding treatments included Previcur Flex, Ranman, Zampro, and Elumin. These treatments were significantly better than the other treatments.

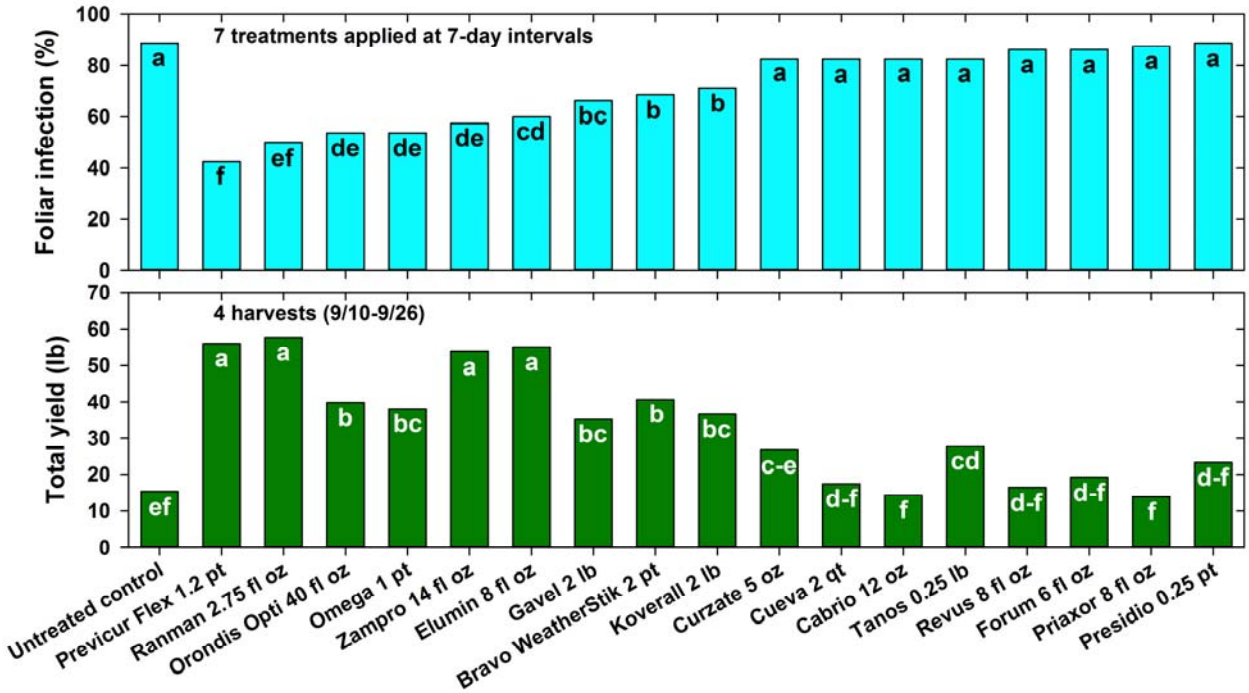

Figure 1. Evaluation of single fungicides to control DM of cucumber.

Trial 2. Evaluation of fungicide programs.

Cucumber 'Vlaspik' seeds were sown on 20 July. Foliar spray treatments were applied on 10, 16, 23 and 30 August; and 7, 14, and 22 September. Foliar infection was evaluated on 29 August; 3, 6, 16 and 25 September. Fruits were harvested on 12, 17, 21 and 26 September.

All treatments except Stargus 3 qt + Bravo + NuFilm, Serenade, Timorex ACT, Double Nickle and AVIV significantly limited DM on the last rating date of 25 September compared to the untreated control (Figure 2). Ranman alone, or as part of a program with Zampro, Bravo, Echo, or Elumin

appeared to be especially effective in protecting the cucumber foliage and were among the higher yielding treatments compared to the untreated control and the other treatments.

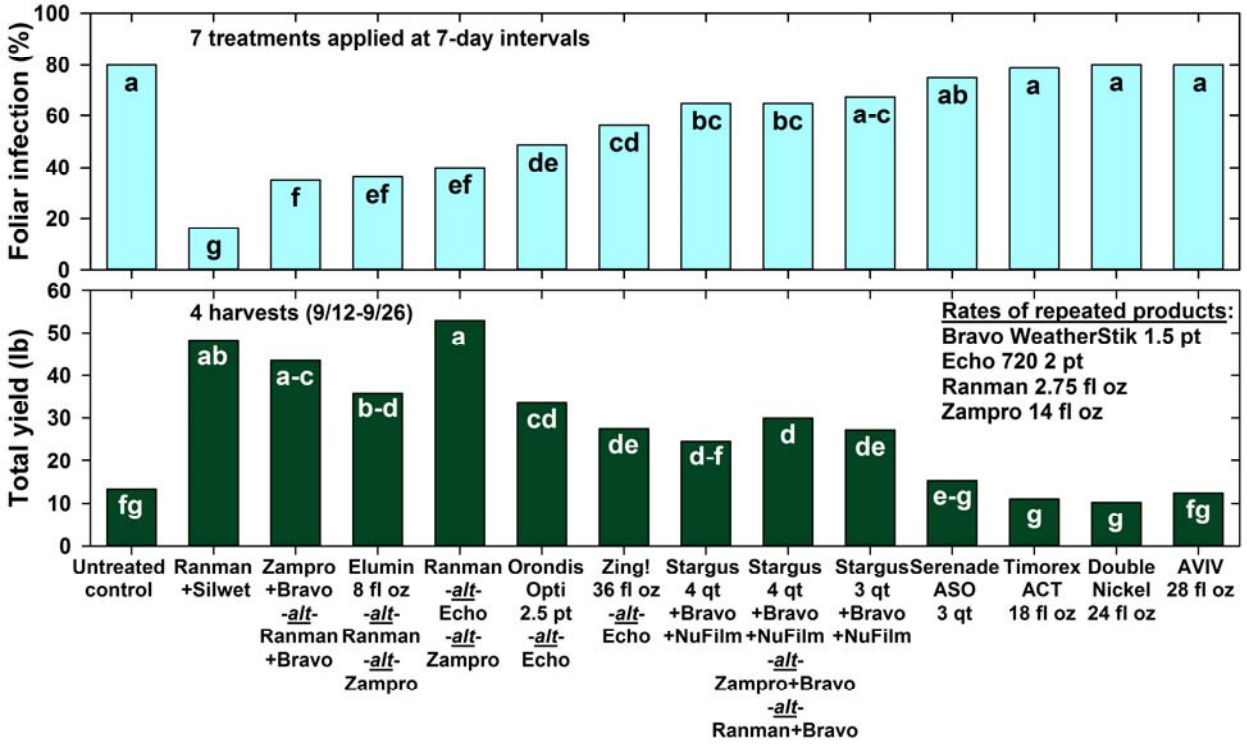

Figure 2. Evaluation of fungicide programs to control DM of cucumber.

Trial 3. Evaluation of alternating programs of registered and experimental fungicides.

Cucumber 'Vlaspik' seeds were sown on 20 July. Foliar spray treatments were applied on 10, 16, 23 and 30 August; 7, 14 and 21 September. Foliar infection was evaluated on 29 August; 3, 6, 16 and 25 September. Fruits were harvested on 12, 17, 21 and 26 September.

All fungicide programs significantly limited DM and yielded more than the untreated control plants (Figure 3).

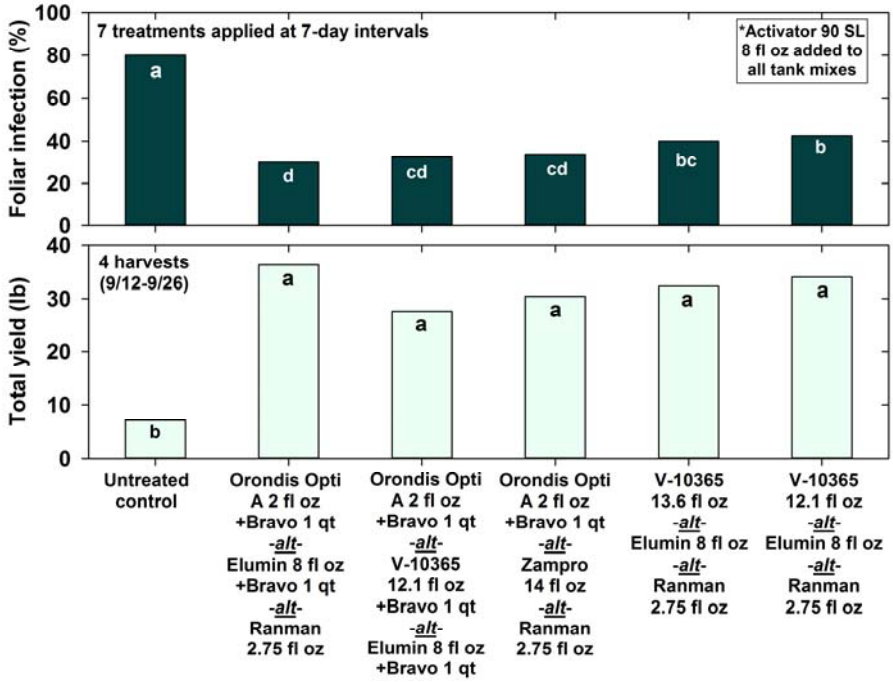

Figure 1. Evaluation of alternating programs of registered and experimental fungicides to control DM of cucumber.

Trial 4. Evaluation of fungicide programs on cucumber cultivars tolerant and susceptible to DM.

DM-tolerant 'Peacemaker' and DM-susceptible 'Vlaspik' cucumber seeds were sown on 30 Jul. Foliar spray treatments were applied on 23 and 30 August; 7, 14 and 21 September. Foliar infection was evaluated on 27 September. Fruits were harvested on 28 September.

Foliar infection reached 21.3% and 82.5% on 'Peacemaker' and 'Vlaspik' untreated cucumber plants, respectively (Figure 4). 'Peacemaker' had less foliar disease compared with 'Vlaspik' for all treatments and the untreated control. On 'Peacemaker' cucumbers, Orondis Opti alternated with Ranman significantly limited DM to 3.0% compared to all other fungicide programs and the untreated control (13.8 to 21.3% foliar infection). On 'Vlaspik' cucumbers, all fungicide treatments significantly limited disease compared to the untreated control; however, Orondis Opti alternated with Ranman was the most effective. 'Peacemaker' yielded more compared with 'Vlaspik' for all treatments and the untreated control. There were no significant differences among treatments for 'Peacemaker' yields. All fungicide treatments significantly increased 'Vlaspik' yields compared to the untreated control.

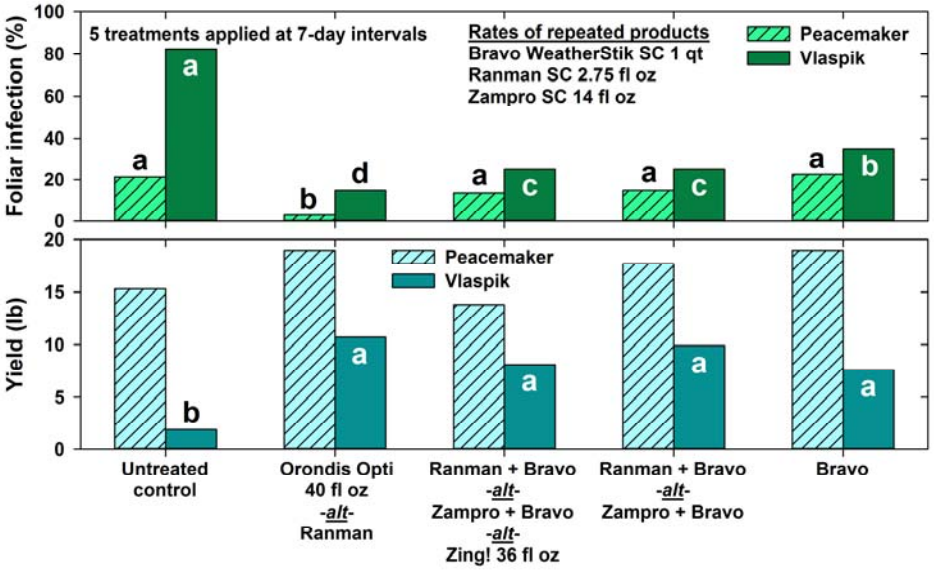

Figure 4. Evaluation of fungicide programs on cucumber cultivars tolerant and susceptible to DM.

This research was supported by funding from the Agricultural Research Fund and Pickle and Pepper Research Committee of Pickle Packers International, Inc., and by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-68004-24931. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Enhancing pollination in pickling cucumber fields

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Production of seeded pickling cucumbers is dependent on pollination. Pollen must be transferred from the male to the female flowers, and bee species are the most efficient organisms at doing this due to the large numbers of flowers they visit in a short period of time. The bee species visiting cucumber in Michigan has been relatively understudied, and we wanted to better understand what was pollinating cucumbers in commercial fields, how rented honey bee colonies could be best managed for yield and honey bee health, and to investigate if there is any possible trade-off between pest management of cucumber and the pollination service they receive.

Pollinator surveys 2017-2018

We surveyed 16 pickling cucumber fields in 2017 and 15 fields in 2018. Fields were surveyed twice during bloom, each time for a 45-minute period. All fields had rented honey bee hives close by. Fields were located in Saginaw and Tuscola counties during 2017, and Gratiot, Isabella, Midland, Saginaw and Tuscola counties during 2018. Honey bees (Table 1) were the dominant pollinators of cucumber fields, accounting for 98-99% of visits across the two years.

Table 1. Summary of bee types visiting pickling cucumber flowers in 2017 and 2018 in central and eastern Michigan.

	2017		2018	
Type of bee	No. visits	Percentage	No. visits	Percentage
Honey bee	1106	98.3	832	98.7
Bumble bee	18	1.6	8	1.0
Other bee	1	0.1	3	0.3

How does management of honey bee hives affect their growth and pollination service?

Honey bee colonies are often moved between cucumber fields on wagons as different fields come into bloom. Movement of hives may disrupt colony growth and development, reducing the number of foraging bees visiting cucumber, and therefore potentially reducing yield. Since honey bees are crucial to cucumber pollination, we investigated how this transport may affect colony growth and whether or not cucumber yield was reduced.

Impact of movement on colony growth

Colonies were placed out in late June. For the comparison, we selected stationary colonies and colonies mounted on wagons in the same landscape around Frankenmuth in Saginaw and Tuscola counties. All hives were managed by the same beekeeper to minimise variation. Colony size was measured at two-week intervals by counting the number of frames covered in worker bees.

Both stationary colonies and colonies on wagons grew in size throughout the season (Figure 1), but growth was greater in stationary colonies. Compared to their size on July 3rd, stationary colonies were 11.9% larger by July 17th-18th, 36.0% larger by July 31st and 43.2% larger by August 15th. In contrast, colonies on wagons grew by 6.7%, 22.2% and 19.4% over the same time period.

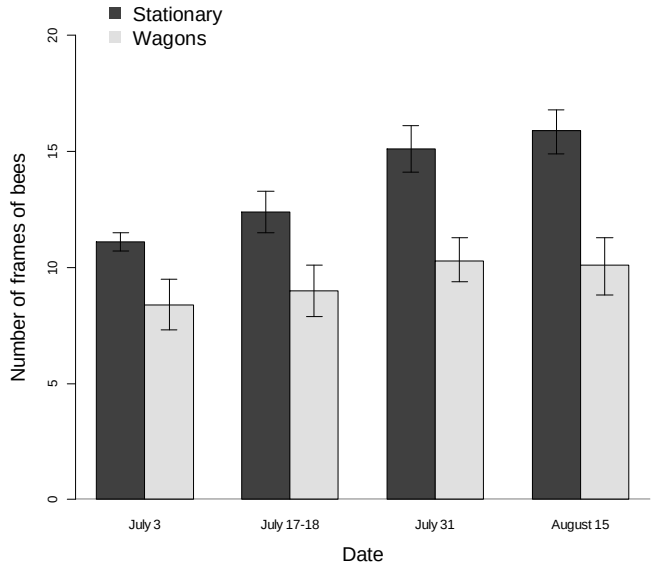

Figure 1. Colony growth in honey bee colonies over the summer, as measured by the number of frames in a hive covered by worker bees. Colonies that remain stationary are marked in dark gray, colonies moved on wagons are marked in light gray.

This difference in relative colony growth is substantial. Starting with four 10-frame colonies (40 frames total) at the beginning of July, if left stationary these will have grown to 57 frames by mid-August, a 43% increase. If instead moved on wagons, these colonies will have only grown to 48 frames over the same time period, a 19% increase. Compared to the moved colonies, the stationary colonies contain 20% more bees, almost the equivalent of an additional hive.

Colonies were given a final health assessment on September 4th-5th. Colony mortality rate was 6.7% for stationary colonies and 4.0% for colonies on wagons. This difference was not statistically significant. For context, as part of other projects during 2018, we followed a total of 71 hives adjacent to cucumber fields. Across all 71 hives, colony mortality was 11.2%, though it is not possible to directly compare this figure due to differences in management strategies used by beekeepers.

Impact of moving colonies on cucumber yield

Across 2017 and 2018 in Gratiot, Isabella, Saginaw and Tuscola counties, cucumber yield data was recorded from 14 fields pollinated exclusively by stationary hives and from seven fields pollinated exclusively by hives mounted on wagons. Yield was assessed by collecting 20 random plants selected from across the whole field a few days before harvest. All cucumbers were stripped from plants and graded according to USDA standards.

In 2017, the average age of cucumber plants at collection was 49 days from planting, with fields harvested at an average of 51 days. In 2018, average age of cucumber plants at collection was 46 days from planting, with fields harvested at an average of 48 days.

Fields pollinated by stationary colonies had higher set rates with an average total of 47.6 grade 1-4 pickles and a greater number of high-quality pickles with an average total of 29.1 grade 2-3 pickles (Figure 2). Fields pollinated by colonies on wagons had a lower set rate (41.7 grade 1-4 pickles) and fewer high-quality pickles (25.7 grade 2-3 pickles). However, these differences were not statistically significant. Overall, fields using stationary colonies had 13% more grade 2-3 pickles per plant and 14% more grade 1-4 pickles per plant.

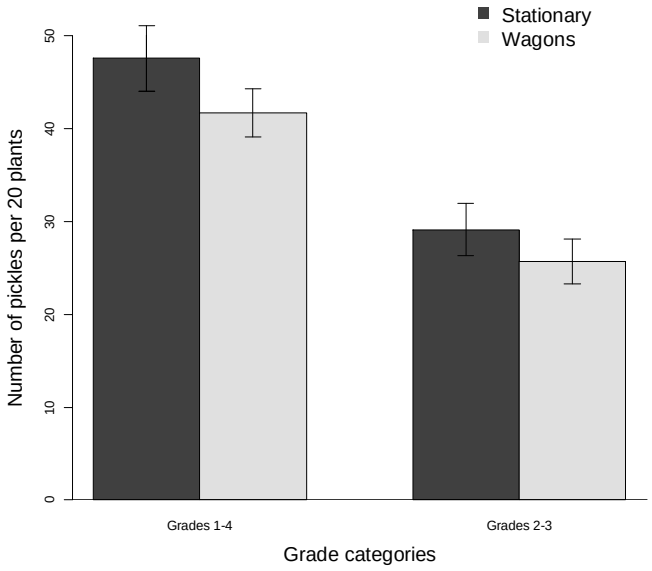

Figure 2. The impact of colony transport mode on pickling cucumber yield per 20 plants. Fields pollinated by stationary colonies are marked in dark gray, fields pollinated by colonies on wagons are marked in light gray.

Does pest management in cucumber affect the pollination service provided by honey bees?

All fields were planted with Farmore 400 (FI400, containing Cruiser insecticide, active ingredient thiamethoxam). Thiamethoxam is a neonicotinoid, and neonicotinoids have been shown to be toxic to bees. Because neonicotinoids are soluble in water, they pass into the pollen and nectar of plants, and honey bees may be exposed to them when visiting cucumber flowers.

In order to assess this exposure, we collected pollen from honey bee colonies from the end of June to early September. We quantified the different pollen types that honey bees fed on, and measured the thiamethoxam residues present in the samples.

Honey bees collected almost no pollen from cucumber flowers, averaging 1.0% of weekly intake over the season. Instead, honey bees foraged extensively from woody plants at the end of June, on corn from mid-July to early August and from wildflowers such as goldenrod from mid-August until September (Figure 3).

Thiamethoxam concentrations were low for the first 8 weeks of the season (late June to mid-August) around 1-2 parts per billion (ppb). Whilst these are very low concentrations, neonicotinoids are acutely toxic to bees and levels of 5-10 ppb over a prolonged period of time are cause for concern. Exposure was highest from mid-August to early September at around 6-12 ppb, at which time honey bees forage mostly on wild plants. There was no relationship between collection of pollen from cucumber and thiamethoxam exposure.

Total thiamethoxam exposure for honey bees across the whole season was greatest in landscapes with more agricultural land. However, there was no significant relationship between the percentage of agricultural land surrounding a cucumber field (total pesticide exposure) and cucumber yield. Thiamethoxam exposure is more strongly impacted by landscape level agricultural management and by the time of the year than by variably blooming, relatively small acreage cucumber plantings.

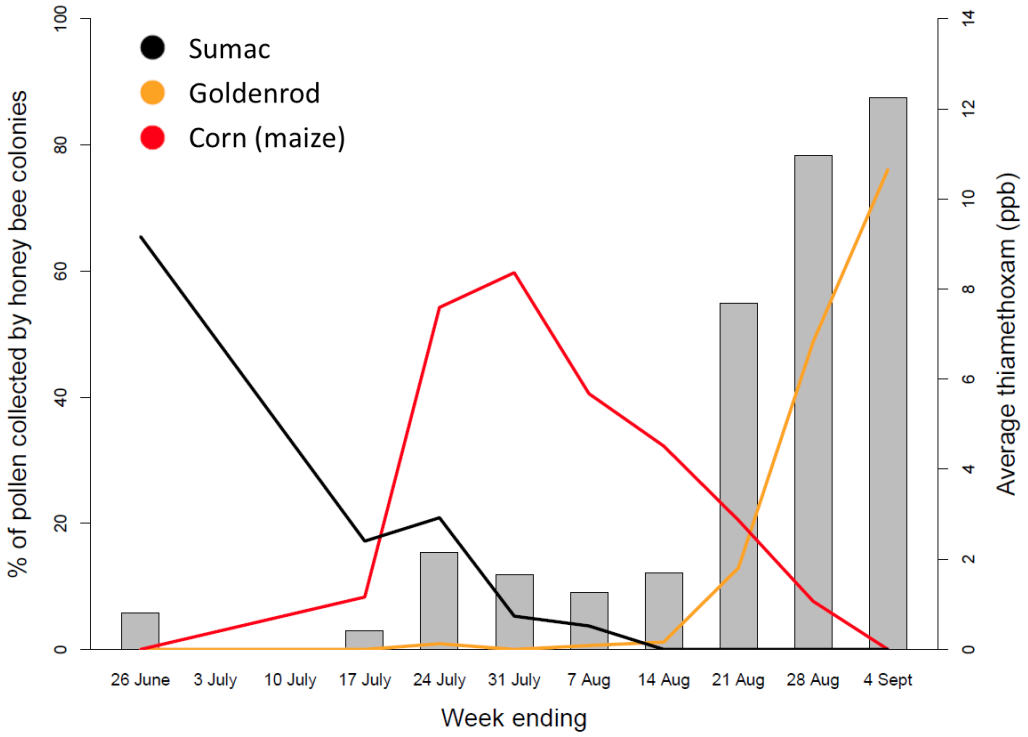

Figure 3. Consumption of major pollen sources by honey bee colonies between late-June and early September 2017. Sumac pollen is marked in black, goldenrod pollen is marked in orange and corn pollen is marked in red. Gray bars indicate average thiamethoxam concentration in pollen in parts per billion (ppb).

Conclusions

Honey bees are critical pollinators for commercial seeded pickling cucumber fields. We found that when colonies are disrupted by being moved on wagons, they grow more slowly and probably result in a small decrease in yield for the cucumber fields they are adjacent to. Honey bees are exposed to insecticides used in cucumber management, but not through interacting with cucumber flowers. Overall rates of exposure are generally within safe limits part from the final two weeks of August into early September. There was no impact of thiamethoxam exposure on cucumber yield. Use of thiamethoxam as a seed dressing on cucumber does not pose a specific risk to honey bee colonies.

Acknowledgements

This material is based upon work funded by the U.S. Department of Agriculture National Institute for Food and Agriculture Speciality Crop Research Initiative number 2016-51181-25410 and the Pickle and Pepper Research Committee of MSU, Pickle Packers International, Inc.