Research Report: Organic Management of Cabbage aphid (*Brevicoryne brassicae*) with insecticides on Brussels sprout in NH: 2016-2018

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Introduction

Cabbage aphid, sometimes described by growers as "gray aphid" or "winter aphid", is a major pest of cruciferous/brassica crops. In recent years, farmers throughout New England have reported economic losses from this pest on several fall Brassica crops, especially Brussels sprout. While conventional insecticide options exist, options for organic growers are limited, and there is a lack of efficacy data to help growers decide among the available options.

Cabbage aphid has a complex life cycle. In warmer parts of the world the cabbage aphid survives solely through asexual reproduction. However, with a colder climate and seasonal variation in photoperiod, cabbage aphid in New England exhibit both asexual and sexual reproduction. Here, cabbage aphid overwinters as eggs laid on a host and possibly as live nymphs in protected environments such as high tunnels or low tunnels. The main source of aphids in the spring hatch from eggs on overwintered brassicas into non-winged aphids. These aphids give rise to winged aphids that are largely responsible for distribution. The first aphids found in crop fields appear in random locations because winged aphids use wind currents for distribution. Once winged aphids land on a plant, they reproduce asexually, rapidly producing a large colony of non-winged nymphs. Once these colonies reach a certain density, new winged aphids are formed, and they spread from these original colonies. In the past few years in Durham, NH, the first winged cabbage aphids appeared in Brussels sprouts during mid-June to late July. It is paramount to scout starting mid-June to "nip" populations in the bud.

The New England Vegetable Management Guide lists a plethora of organic pesticides for treatment of cabbage aphid. Cornell University's Organic Production and IPM Guide for Cole Crops (Seaman, 2016) recently compiled results of published pesticide efficacy studies. Several insecticides were considered to provide "good" control of aphids in general, however, few studies specifically evaluated efficacy on cabbage aphid. Discussions with growers, researchers and entomologists in the region helped narrow the choice of pesticide treatments used in this experiment to focus on those most likely to provide effective control of the cabbage aphid. The three materials evaluated were: AzaGuard [azadirachtin], Azera [azadirachtin and pyrethrins] and M-Pede [potassium salts of fatty acids]. Azadirachtin is the active ingredient in many organic pesticides for aphid control; it is derived from the neem plant. Pyrethrins are botanical extracts derived from the chrysanthemum plant. These were the only products found to be effective at controlling aphids in over half of the

studies summarized by Seaman (2016). Insecticidal soap was included as an inexpensive and readily available insecticide.

Our objective was to better understand the chemical control of cabbage aphid in Brussels sprout using certified organic-compliant materials. We aimed to answer the following questions:

1. Will the use of insecticides Azera and M-Pede, in rotation, effectively control cabbage aphid on Brussels sprout? (implemented in 2016)
2. Will M-Pede, Azera, and/or AzaGuard on their own effectively control cabbage aphid? (implemented in 2017)
3. When do we need to start applying these materials, and how often do they need to be applied?

What we did

Brussels sprout seeds (cv. Diablo, Johnny's Selected Seeds) were sown on 20 May 2016 and 24 May 2017 into 128 plastic cell trays using Promix BX (Pro-Mix, Quakertown, PA) soilless media. Prior to planting, 120lbs/acre of nitrogen (N) as 27-0-0 and 150lbs/acre of K_2O as 0-0-60 were incorporated in the spring based on soil test recommendations. Raised beds covered with 0.6 mil biodegradable black plastic mulch (Organix A.G. Film) were created with a bed-former that lays 1 line of drip tape about 1 inch below the soil surface. Brussels sprouts were transplanted on 21 June 2017 and 16 June 2017 into the field. Brussels sprouts seedlings were planted at 18 inch spacing with 6 feet between rows. The soil moisture surrounding the roots was regularly evaluated. On average, the drip irrigation ran about 1.5 hours per week in 2017, whereas in 2018 drip irrigation was only run twice due to regular rainfall.

Dipel® DF (***B. thuringiensis*** var. ***kurstaki)*** in combination with NuFilm P spreader-sticker was applied to the entire field throughout the growing season as needed to combat caterpillar pests. Applications rates ranged from 0.5lbs/acre when plants were young to 2lbs/acre when plants were larger, as greater amounts of mixed material was needed to ensure good coverage. Brussels sprouts were topped (the apical meristem was removed) during the week of September 15. For more information on topping, visit
https://extension.unh.edu/resources/files/Resource003914_Rep5563.pdf

Experimental Layout and Explanation of Insecticide Treatments

We made decisions about when to apply pesticides for cabbage aphid by following the sequential sampling protocol for economic thresholds for cabbage aphid published by the University of California UC IPM: UC Management Guidelines for Cabbage Aphid on Cole Crops. Based on number of data plants per plot, we sprayed when thresholds reached 14% of plants with at least one cabbage aphid per plot. All cabbage aphid treatments were surrounded by untreated plots that became highly infested with cabbage aphid. In both years we used a randomized complete block design. **In**

2016 there were 4 replications of treatments. The insecticide treatment was a rotation between M-Pede and Azera and it was compared against untreated control plots.

Table 1. Insecticide treatments, active ingredients, and rates.

Pesticide Material	Active Ingredient	Rate of concentrate
Azera (MGK)	azadirachtin and pyrethrins	177 mL per 3 gallons of water
M-Pede (Gowan Co.)	potassium salts of fatty acids	207 mL per 3 gallons of water
Aza Guard (BioSafe Systems LLC) + **Nu Film P** (MKG)	azadirachtin and spreader-sticker	28.5mL + 4.9mL per 3 gallons of water

In 2017 and 2018, there were 3 replications of 3 insecticide treatments (M-Pede, Azera, and AzaGuard with NuFilm P) compared against untreated control plots. All treatment rates remained the same throughout the growing season; sprays were not rotated.

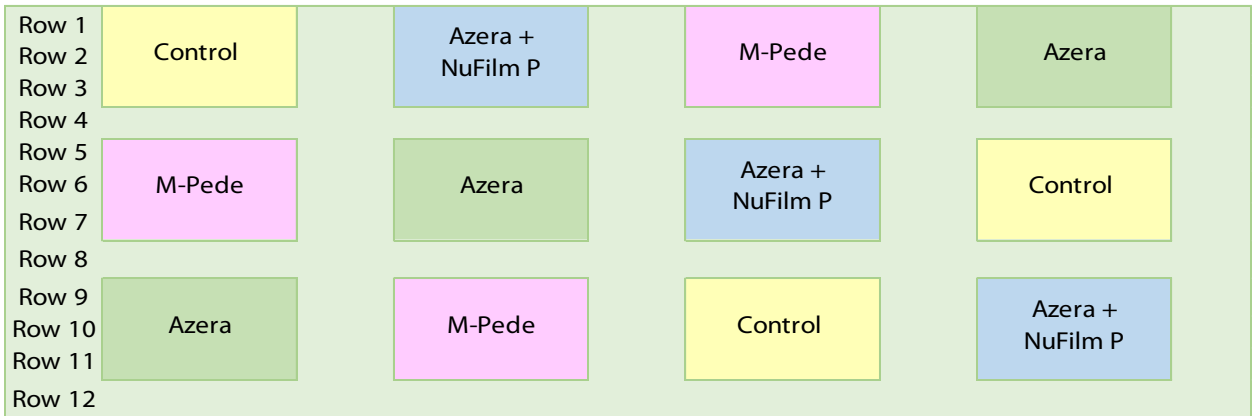


Figure 1. Randomized complete block design of insecticide treatments used in 2018.

In all years, treatment plots were surrounded by rows of plants that were not sprayed with aphid materials to insure high infestations of cabbage aphid. Insecticide treatments were applied to each plot using a dedicated backpack sprayer.

Data collected

Aphid presences on Brussels sprout leaves throughout the season. Every week, we counted all aphids on both sides of 6 leaves for nine plants in each plot.

Percent of infested sprouts at final harvest. At harvest time, we selected 6 (in 2016) or 8 (in 2017) plants from the middle row of each plot. All leaves were removed and we determined the

percentage of infested sprouts per stalk. Because there were no cabbage aphid in 2018, final harvest data were not collected.

Results and Conclusions

Economic Damage Thresholds. In **2016**, economic damage thresholds were first reached on 19 July and not again until about 2 months later. In **2017**, economic damage thresholds were reached on 14 August and remained at damaging levels until 23 October when aphid populations in all plots, including the control plot, plummeted. In **2018,** economic damage thresholds were never reached in any plot.

Number of cabbage aphid insecticide application dates. In **2016,** cabbage aphid insecticide treatments were applied on eight dates, alternating between Azera and M-Pede (as shown in Table 2, below). In **2017**, cabbage aphid insecticides (Azera, AzaGuard, M-Pede) were applied on seven dates as plots reached economic damage thresholds. Dipel DF + NuFilm-P was applied six times in 2016 and four times in 2017. In **2018**, no cabbage aphid insecticides were applied, because action thresholds were never reached.

Table 2. Dates of insecticide applications in 2016 and 2017.

2016			2017	
Cabbage aphid insecticide	**Cabbage aphid application dates**	**Dipel DF + NuFilm-P**	**Cabbage aphid application dates**	**Dipel DF + NuFilm-P**
M-Pede	19-Jul	8-Jul	14-Aug	26-Jun
Azera	13-Sep	11-Jul	24-Aug	21-Jul
M-Pede	22-Sep	26-Jul	5-Sep	28-Aug
Azera	28-Sep	12-Aug	14-Sep	5-Oct
M-Pede	7-Oct	1-Sep	26-Sep	-------
Azera	12-Oct	9-Sep	12-Oct	-------
M-Pede	20-Oct	-------	23-Oct	-------
Azera	2-Nov	-------	-------	-------
Number of applications	8	6	7	4

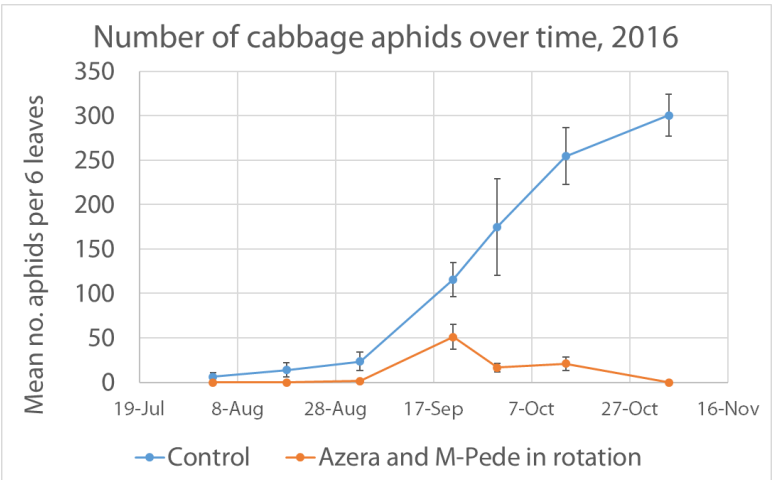
Cabbage aphid populations.

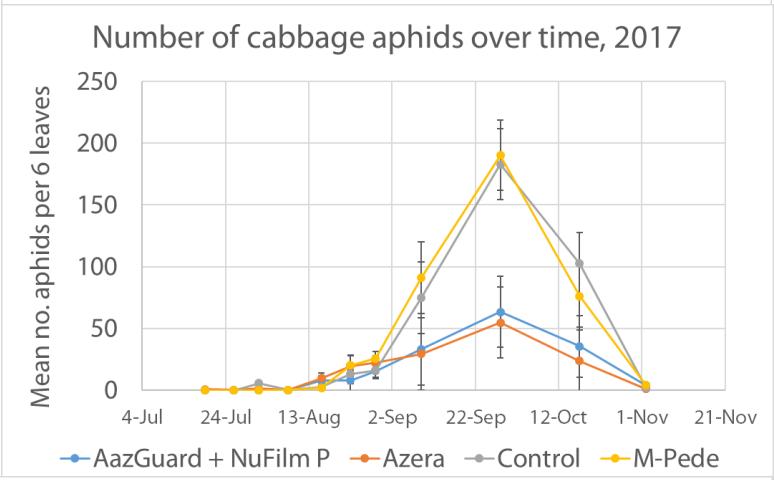
In **2016**, cabbage aphid numbers continued to rise into November. Starting on 30 Sept., there were significantly fewer cabbage aphid in the insecticide-treated plots than in the control plots.

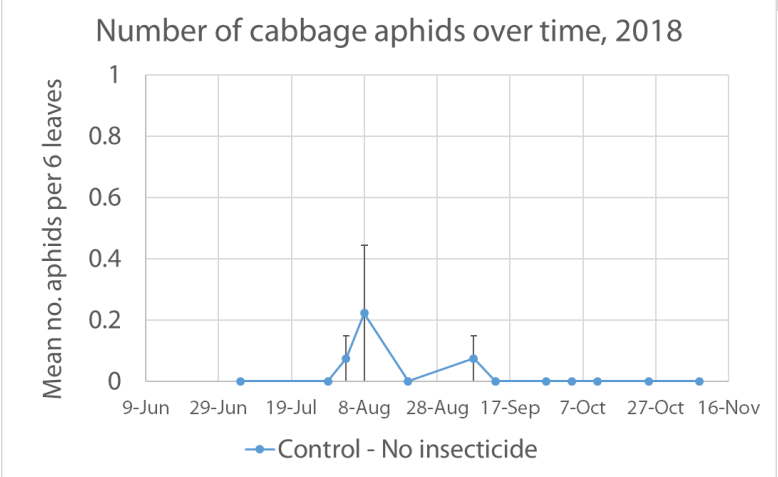
In **2017**, the first winged aphids began to fly into the field in mid-July, distributed in patches throughout the field. Cabbage aphid populations peaked on 28 Sept., when every single Brussels sprout plant in the field had a least one aphid. This was the only date where insecticide treatments showed significant differences. Cabbage aphid populations were significantly higher on Control and M-Pede plots than on AzaGuard and Azera-treated plots. Aphid populations declined suddenly in October. There are several possible reasons for this: sudden storms with high winds and rain, entomopathogenic fungal infections, and predation by natural insect predators (syrphid, cecidomyiid, and lady beetle larvae and adults).

There were very few cabbage aphids in **2018.** One contributing factor may have been the substantial regular rain throughout the summer. Population fluctuations from year to year emphasize the importance of scouting to make informed insecticide application decisions.

Note: In our study, each plot was surrounded by untreated plots that became highly infested with cabbage aphid. This created an artificially high population of cabbage aphid compared to what growers might experience if the entire field had been sprayed. Thus, the chosen insecticides might have shown better efficacy under commercial farm conditions.







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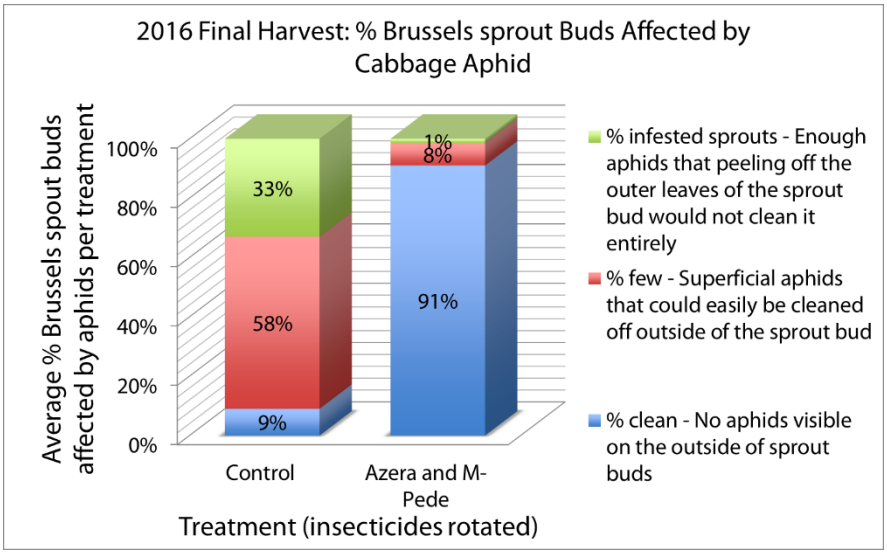
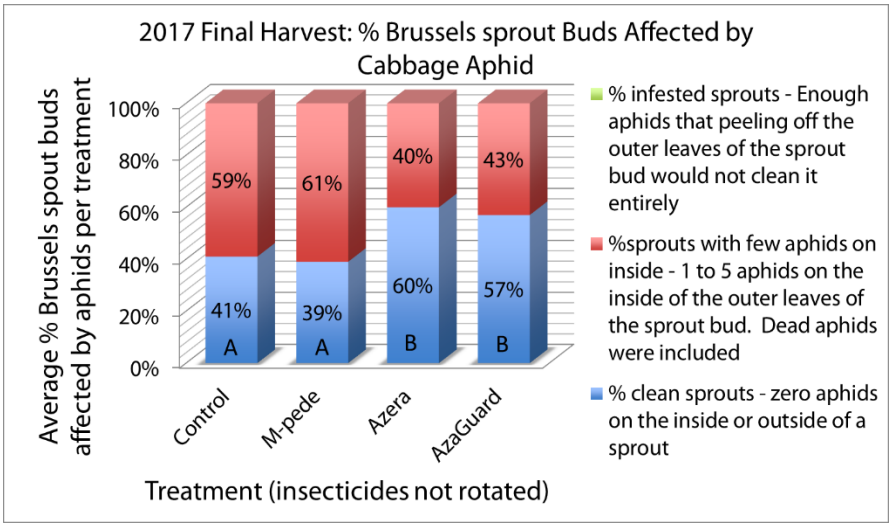
2016 Final Harvest Results.

Azera and M-Pede in rotation significantly reduced the number of aphids on the Brussels sprouts. At final harvest, 91% of sprouts were completely clean of aphids, or had just a few superficial aphids that could be easily wiped off, compared with 8.9% in control plots.



2017 Final Harvest Results.

At first glance, all insecticide treatments provided adequate control of cabbage aphid. There were no thoroughly infested sprouts in 2017. However, upon closer inspection, small numbers of mostly dead aphids were found on the inside of the outer leaves of many Brussels sprouts. Thus, suitability for some markets could have been compromised. In 2017 we used a stricter definition of "clean sprouts" than 2016 to highlight differences in treatments. "Clean" sprouts had <u>zero</u> aphids outside or inside the outer leaves of the sprout. Azera and AzaGuard treatments had significantly more clean sprouts (59% and 57%) than the unsprayed (42%) and the M-Pede (39%) treatments. M-Pede was not statistically different from the unsprayed plot. M-Pede (alone, without rotation of other insecticides) was found to be the least effective spray treatment. Other university studies have confirmed poor aphid control when using M-Pede alone, however there has been some preliminary success using M-Pede as a synergist when mixed with other insecticides.



Treatments not connected by the same letter are significantly different from each other.

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Conclusions/Suggestions for Growers

- Regular scouting for cabbage aphids, and application of insecticides at pre-determined economic thresholds, resulted in 7-8 applications of materials in 2016 and 2017. Single applications of these materials early in the season are unlikely to give sufficient control, and repeated applications and continued scouting is likely to be needed.
- Regular and timely scouting is key to disrupt the formation of larger cabbage aphid colonies.
- Cabbage aphid populations fluctuate from year to year.
- Azera, AzaGuard+Nu Film P, or Azera and M-Pede in rotation provided some control against cabbage aphid but did not confer complete control.

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