Evaluation of a Grower-friendly Attract-and-kill Strategy for Apple Maggot Control in New England Apple Orchards

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In New England and New York, and to a lesser extent in apple production areas south of these states, the apple maggot fly (AMF) has historically been the sole fruit-injuring pest active after June against which insecticide is applied to apple orchards. Currently, one exception is the invasive pest brown marmorated stink bug in states where populations are causing agricultural damage. Given that the principal threat of AMF injury in commercial orchards arises from flies immigrating from unmanaged hosts, then attract-and-kill strategies that intercept immigrating AMF before they have the opportunity to penetrate into the apple blocks could prove effective at managing AMF.

Previously, trap-based control strategies have focused on captures of AMF at the orchard perimeter using either, odor-baited Tangletrap-coated red spheres or odor-baited attracticidal spheres, with excellent results. The attracticidal sphere is made of a red plastic sphere topped by a disc comprised of an insecticide, sugar (as feeding stimulant) and paraffin wax (as binder). Multi-year research involving use of odor-baited sticky spheres and attracticidal spheres has clearly demonstrated the potential of controlling AMF in commercial orchards. However, several concerns have prevented the use of these devices for AMF control by commercial growers. For example, sticky spheres must be maintained at least biweekly to retain capturing effectiveness, and the labor and mess associated with handling sticky-coated traps on a large scale are prohibitive to commercial application. Unfortunately, regulatory hurdles, among other issues, have largely prevented the further research and development, leading to commercialization, of attracticidal spheres. While research involving the optimization of attracticidal spheres continues to be conducted, it is imperative to evaluate alternative control strategies for AMF that could be implemented right away by growers.

The goal of this study was to assess the level of AMF control achieved in commercial orchard blocks using an attract-and-kill strategy involving use of synthetic lures deployed in perimeter-row trees in combination with insecticide sprays with 3% sugar added to the tank mix. Sugar is a phagostimulant that readily induces feeding by adult fruit flies upon contact. We expected to bring AMF adults to perimeter-row trees where they could be killed by the insecticide sprays, before they could penetrate into interior trees. Subsequent flies arriving to the baited tree canopies were expected to continue sensing sugar on the foliage and fruit, inducing flies to ingest insecticide residue.

Materials & Methods

This study was conducted in six commercial apple orchards (3 in Massachusetts, 2 in New Hampshire, and 1 in Maine). For each orchard, growers made two

Table 1. Area of the experimental blocks and number of synthetic lures used in the attract-and-kill blocks in six commercial orchards located in Massachusetts, New Hampshire, and Maine, in 2019.

Orchard	Area (A&K / GC)	No. AMF lures (A&K block)
Clarkdale (MA)	1.7 ac / 1.7 ac	11 lures (5.8/ac)
Red Apple (MA)	3.0 / 2.8 ac	13 lures (4.3/ac)
UMass Cold Spring Orchard	1.8 ac / 2 ac	10 lures (5.5/ac)
Poverty Lane (NH)	3.5 ac / 2.7 ac	13 lures (3.7/ac)
Apple Hill (NH)	4 ac / 3.8 ac	17 lures (4.3/ac)
Ricker Hill (ME)	5 ac / 5 ac	25 lures (5.0/ac)

blocks available for the research. While the size of the blocks ranged from 1.7 to 5 acres (Table 1), efforts were made to have the two blocks of similar size within each orchard. Each of the four sides of a block was bordered by grower-sprayed orchard trees, open field, hedgerow, or woods. For each orchard, two treatments were evaluated (1) attract-and-kill and (2) grower control.

The attract-and-kill block made use of 5-component lures (= 'attract' component) deployed every ~30 yards along the four perimeter rows. The lures were purchased from Great Lakes IPM. The average lure density was 5 per acre (Table 1). The 'kill' component of this strategy consisted of insecticide sprays mixed with 3% sugar (3 lbs. per 100 gallons of water) applied during July and August. The control block was treated by the grower most commonly with two or three insecticide sprays to control AMF. Each participant grower applied the insecticide of their choice, most commonly the organophosphate imidan (phosmet) and the neonicotinoid Assail (acetamiprid). One orchard alternated the use of Assail, the anthranilic diamide Exirel (Cyantraniliprole), and the neonicotinoid Belay (Clothianidin).

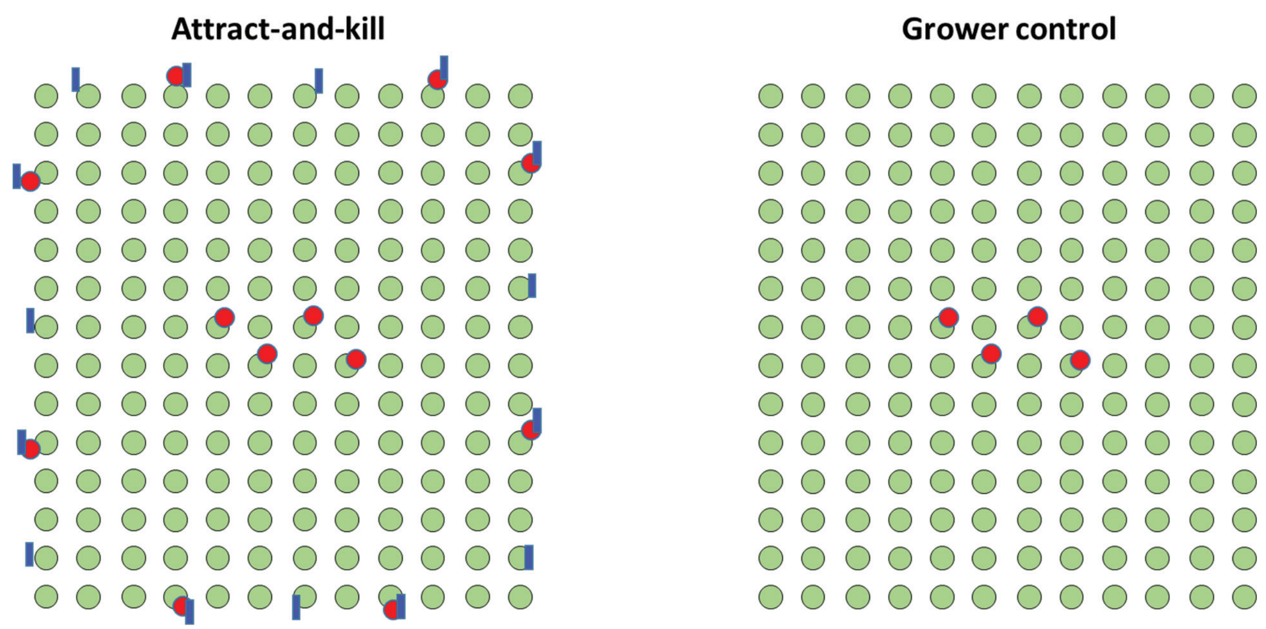

Figure 1. Schematic illustration of the 2019 field layout for evaluation of an attract-and-kill strategy for managing apple maggot fly involving (1) use of synthetic lures (blue rectangles) deployed on perimeter-row trees and (2) sugar added to insecticide sprays that were confined to perimeter-row trees only. The efficacy of this management approach was compared against grower control blocks subjected to 2-3 insecticide sprays. Red circles: red sticky monitoring spheres. All red sticky spheres deployed in the interior of blocks were unbaited.

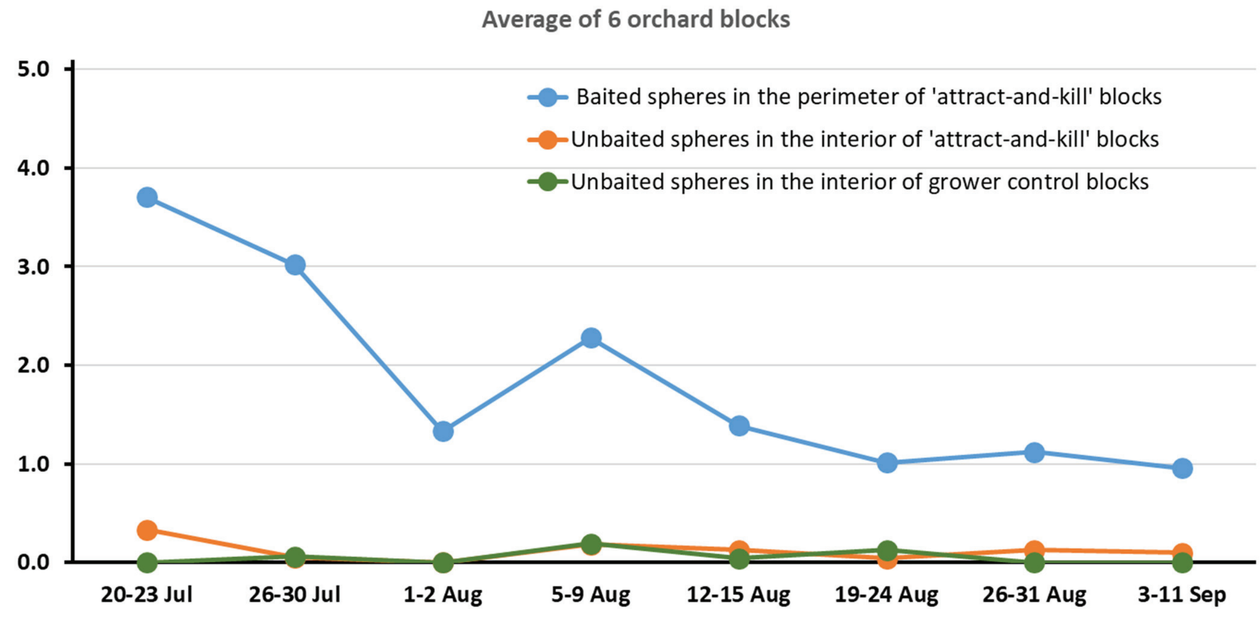

Figure 2. Weekly average captures of wild AMF in red sticky spheres deployed on perimeter-row trees (baited spheres= blue line) and on interior trees (unbaited spheres= orange line) of attract-and kill blocks. Grower control blocks had unbaited sticky spheres deployed on the most interior trees (green line).

AMF monitoring. Due to logistic constrains, monitoring spheres were deployed in mid-July 2019. The attract-and-kill block received 6-8 unbaited red sticky spheres (3.5 inches in diameter) to quantify AMF densities on perimeter-row trees (Figure 1, Table 1) whereas the grower control blocks had no sticky spheres in the perimeter. Each of the two blocks received 3-4 unbaited sticky spheres in the most interior trees to monitor the degree of AMF penetration (Figure 1).

Assessment of treatment performance. We used two methods of assessing treatment performance. First, every week from trap deployment until harvest we counted and removed all AMF captured by the red sphere traps placed on perimeter-row trees and on interior trees of attract-and-kill plots, and by the unbaited spheres in the interior of grower-sprayed plots. Captures by interior spheres were used as an indicator of relative numbers of AMF adults that penetrated into the interiors of the two types of blocks. Second, at harvest we sampled 20 fruit from each of five trees on each of the four sides of each baited-sphere and each grower-sprayed plot plus ten fruit on each of five interior trees, for a total of 500 fruit per block. All sampled fruit that were suspected to have AMF injury upon visual inspection were brought to the laboratory (UMass Amherst), where they were kept inside individual plastic containers with moist sand (as a pupation substrate) at 70-75 degrees Fahrenheit for six weeks. Then, each fruit was dissected for signs of tunneling and/or presence of AMF pupae in the sand.

For this study to be considered successful, we expected AMF numbers on perimeter-row monitoring spheres to be significantly greater than the number recorded on interior sticky spheres of attract-and-kill blocks. We also expected no differences in the level of AMF penetration, as measured using interior unbaited spheres, into either type of block.

Results

AMF trapping. For each trap inspection session, red sticky spheres deployed on perimeter-row trees in association with synthetic AMF lures in attract-and-kill blocks captured substantially more (9-60 times more) wild AMF than interior unbaited spheres in the same blocks (Figure 2). This result indicated that the

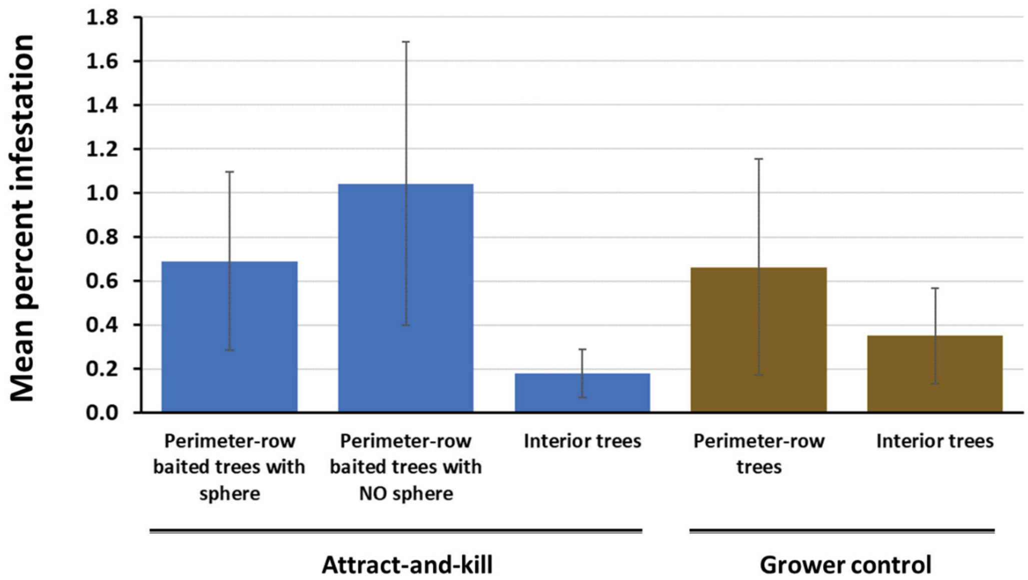

Figure 3. Mean percent fruit injured in attract-and-kill (blue bars) and grower-sprayed blocks (brown bars) in 2019.

lures were effective at pulling AMF to perimeter-row trees. Overall, AMF captures in unbaited monitoring spheres deployed in the interior trees of both blocks were very low, and there was virtually no difference in the level of AMF pressure in the interior of attract-and-kill blocks (despite the lack of insecticides sprayed inside those blocks) and the grower control blocks (Figure 2).

Infestation data. The percentage of fruit that was infested with AMF larvae was statistically similar regardless of whether the fruit was sampled from attract-and-kill blocks o from grower control blocks. While some variability in results was observed, the amount of fruit injured was numerically greatest on perimeter row-trees and lowest on interior trees, for both types of blocks (Figure 3). Because the number of AMF lures deployed on perimeter-row trees was greater than the number of red sticky-coated monitoring spheres, and therefore some trees had lures but no red sticky spheres, then the results from fruit sampling are presented separately for perimeter-row trees that harbored (or not) a baited monitoring sphere. The results show that the presence of lures in the absence of a red sticky sphere does not lead to greater AMF infestation on those

Conclusions

Results from this single-season study indicate that an attract-and-kill approach involving synthetic lures deployed on perimeter-row trees in association with perimeter-row sprays of insecticides containing 3% sugar was effective in controlling AMF, as determined by trap captures and infestation data, when compared to grower control blocks. Future research ought to compare the performance of the attract-and-kill strategy involving perimeter-row sprays of insecticide mixed with sugar against that of perimeter trapping using odor-baited spheres in the absence of insecticide sprays. Conducting this type of research using a greater number of orchards is expected to reduce variability in results.

Acknowledgments

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