Evaluation of a Grower-friendly Attract-and-kill Strategy for Apple Maggot Control in New England Apple Orchards: Research Results for Year Two

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Admittedly, most of the damage caused by the apple maggot fly (AMF), *Rhagoletis pomonella*, in commercial orchards originates from adults immigrating from unmanaged hosts. One behaviorally-based approach that was developed for AMF control is an attract-and-kill (= AK) system involving either, odor-baited Tangletrap-coated red spheres, or maintenance-free odor-baited attracticidal spheres which have contoured tops that provide sustained release of both insecticide and feeding stimulant under field conditions. However, while both trapping devices are effective at controlling AMF, grower adoption has not materialized due to concerns involving the amount of labor involved in the case of sticky spheres, costs, and even regulatory hurdles that have largely prevented further research and development of attracticidal spheres.

In the spring 2020 issue of *Fruit Notes* we reported on the effectiveness of a novel AK system, evaluated in 2019, that makes use of synthetic lures deployed in perimeter-row trees in combination with insecticide sprays with 3% sugar (as a feeding stimulant) added to the tank. In that study, we demonstrated that the lures attracted AMF adults to perimeter-row trees where they were presumably killed by the insecticide/sugar sprays, before they could penetrate into the orchard blocks trees. The 2019 study was conducted in six commercial orchards.

Here, present the results of a 2020 field study that was conducted in 11 commercial orchards located in Massachusetts, New Hampshire, and Maine. Our main goal was to validate the results of the 2019 study.

Material & Methods

Study sites and treatment description. This research study was conducted in 11 commercial apple

Table 1: Area of the attract-and-kill (= AK) and grower control (= GC) blocks and number of AMF lures used in AK blocks in 11 commercial apple orchards located in Massachusetts, New Hampshire, and Maine in 2020. CSO-1= UMass Cold Spring Orchard (CSO) block 1; CSO-2 = UMass CSO block 2.

Orchard	Area AK block / GC block	No AMF lures deployed in AK blocks
A	6.5 ac. / 7.8 ac.	24
B	1.4 ac. / 1.7 ac.	11
C	1.1 ac. / 1.6 ac.	6
D	7.1 ac. / 1.0 ac.	28
E (CSO-1)	3.7 ac. / 1.2 ac.	17
F (CSO-2)	1.9 ac. / 1.2 ac.	12
G	1.2 ac. /1.2 ac.	10
H	3.3 ac. / 2.6 ac.	16
I	3.3 ac. / 4.0 ac.	16
J	1.1 ac. / 0.5 ac	16
K	2.5 ac. / 2.0 ac.	14

orchards located in Massachusetts (7 orchards), New Hampshire (3 orchards), and Maine (1 orchard). Within each orchard, there were two treatment blocks: (1) Attract and kill (= AK), and (2) Grower control (= GC). The area of each type of block is presented in Table 1.

In the AK block, the "attract" component consisted of AMF lures containing attractive synthetic apple odor (purchased from Great Lakes IPM). The lures were deployed every 30 yards along the entire perimeter of the block. 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 to the perimeter of the blocks during July and August.

The GC block received no lures and no sugar in the sprays. Insecticides targeting AMF were applied to the entire block, as deemed necessary by the grower. Each participant grower applied the insecticide of their choice, most commonly the organophosphate Imidan (Phosmet), the neonicotinoid Assail Acetamiprid), the anthranilic diamide Exirel (Cyantraniliprole), and the neonicotinoid Belay (Clothianidin).

AMF monitoring and fruit injury assessments. We quantified AMF populations using red sticky spheres (3.5 inches in diameter) on a weekly basis. Both the AK and the GC blocks received 8 sticky spheres on perimeter-row trees (Figure 1). Four unbaited sticky spheres were deployed on the most interior trees of each block to monitor the AMF penetration rate (Figure 1). The number of AMF captured by the red monitoring spheres was recorded every week from trap deployment (in late June) until harvest. Captures by interior spheres were used as an indicator of the relative numbers of AMF adults that penetrated into the block interior.

At harvest, for each block we visually inspected 20 fruits from 16 trees located left and right of a monitoring sphere, and from 8 trees located in the block interior, for a total of 480 fruits per block. Across all 11 orchards and

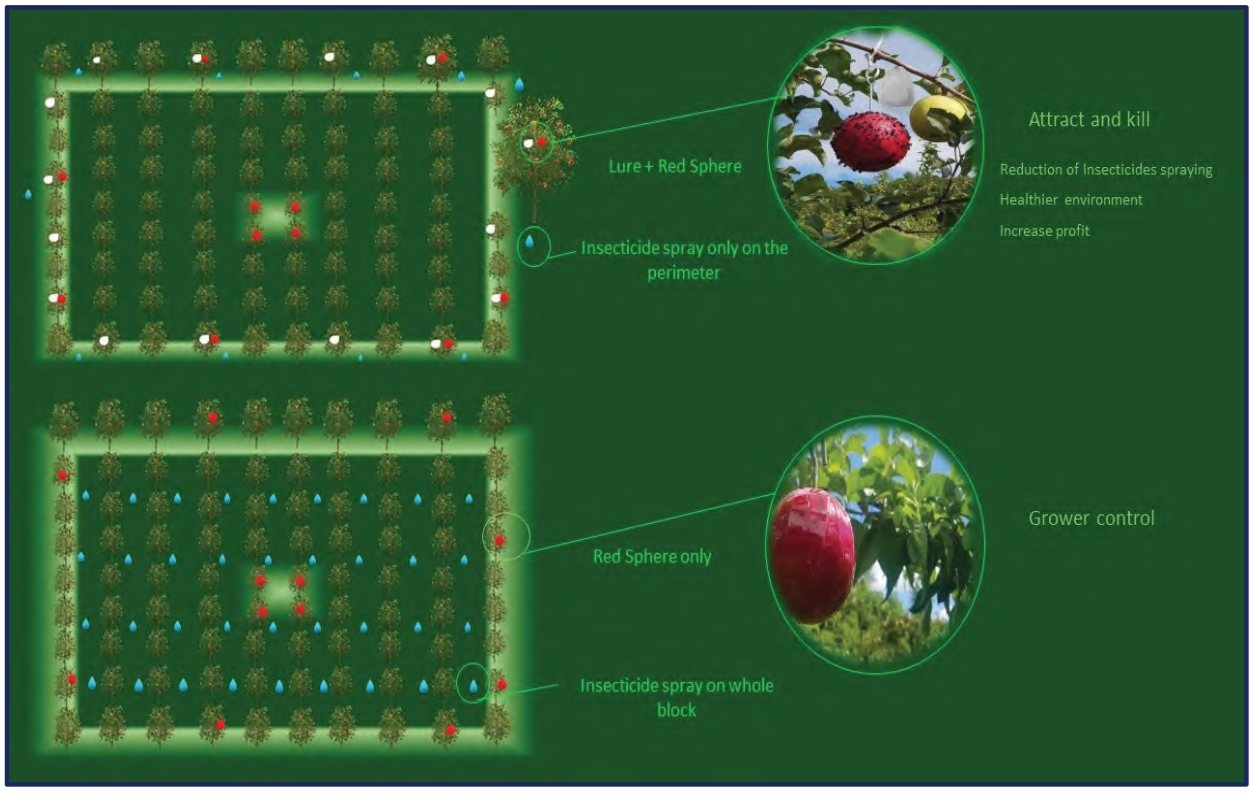

Figure 1. Schematic illustration of the 2020 evaluation of an attract-and-kill (AK) strategy for apple maggot fly control involving (1) use of synthetic lures deployed on perimeter-row trees in AK blocks and (2) sugar (3%) added to the insecticide sprays that were confined to perimeter-row trees only. The efficiency of this management was compared against grower control blocks. The red circles are indicative of the location of red sticky spheres in both types of blocks and the white circles represent lures deployed in AK blocks only.

blocks, 10,560 fruits were visually inspected. All fruits that were suspected of having AMF egg-laying injury upon visual inspection were brought to the laboratory (UMass Amherst) and were kept inside individual plastic containers with moist sand (as a pupation substrate) at 75° F for six weeks. Then, each fruit was dissected for signs of tunneling and/or the presence of AMF pupae in the sand. Here, we are reporting confirmed injury levels, which are lower than the suspected injury levels that were recorded in the harvest surveys.

This research was considered effective if (1) AMF numbers on perimeter-row monitoring spheres were significantly greater than the number recorded on interior sticky spheres of AK blocks, and (2) if similar levels of AMF control, as reflected by infestation rates, occurred in the AK and GC blocks.

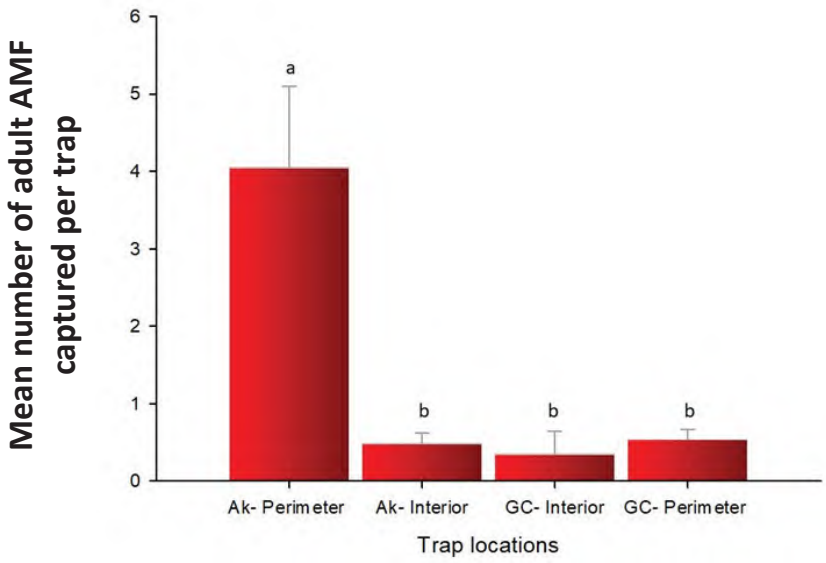

Figure 2. Mean number of adult AMF (males and females combined) captured in red sticky monitoring spheres according to treatment. Bars superscribed by the same letter are not significantly different at odds of 19:1.

Results

AMF trapping: Results indicated that AMF captures by baited sticky spheres in perimeter-row trees in association with synthetic AMF lures in AK blocks were significantly greater than AMF captures in perimeter rows of GC blocks, which had unbaited spheres (Figure 2). This indicates that the lures were efficient at pulling AMF adults to the perimeter, thus preventing them from penetrating into the block interior. No significant difference was observed between the unbaited monitoring spheres deployed in interior trees of both types of blocks (Figure 2), despite the fact that the interior of AK blocks did not receive insecticides. Since insecticides were used only in the perimeter of AK blocks, the total amount of insecticide used was lower than the amount used in GC blocks. As shown in Figure 3, the peak of AMF captures in AK blocks, across all orchards, took place in early August.

Infestation data: The confirmed AMF infestation levels were 0.04% across all 11 orchards and, similar to the first-year study (in 2019), the amount of fruit injured (expressed as a percentage) did not differ between AK blocks and GC blocks.

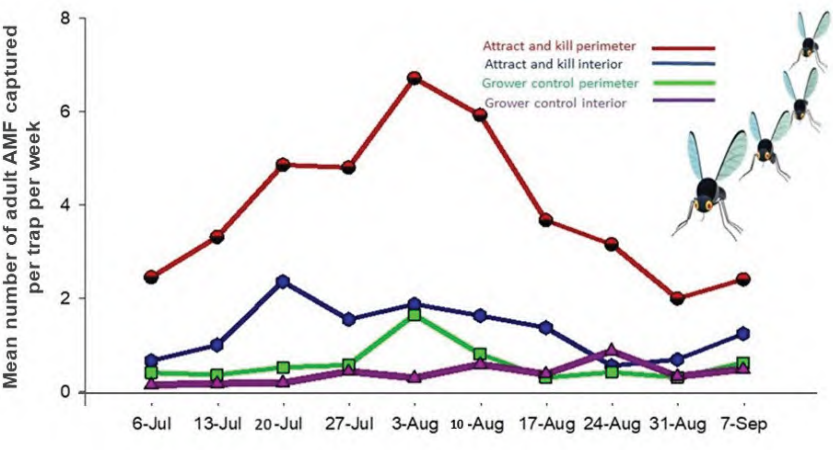

Figure 3: Mean weekly captures of wild AMF (males and females combined) in red sticky spheres deployed in perimeter-row trees in attract-and-kill blocks (red line) and in interior trees (blue line). Grower control blocks received unbaited sticky spheres deployed in the perimeter (green line) and in interior trees (purple line).

Conclusions

Results from this second-year study confirmed 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 efficient in controlling AMF, as determined by trap captures and infestation data, when compared to grower control blocks.

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