Ideal Within-canopy Positioning of Odor-baited Red Spheres for Monitoring or Control of Apple Maggot Flies

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About 20 years ago, we conducted tests aimed at establishing favorable positions within canopies of apple trees for deploying unbaited sticky red spheres to capture apple maggot flies (AMF). We found that removal of all foliage and fruit within 10 to 20 inches of a red sphere resulted in greater AMF captures than allowing foliage and fruit to encroach within 3 inches of a sphere or removing all foliage and fruit within 40 inches of a sphere. Since the time of this initial study, researchers at the New York Agricultural Experiment Station in Geneva have developed a blend of synthetic, attractive apple volatiles that draws AMF toward blend-baited trees and enhances captures of AMF by red spheres deployed in blend-baited trees.

Here, we report on experiments conducted in 2002 and 2003 aimed at defining favorable positions within apple trees for deployment of blend-baited red spheres for capturing AMF. We asked three questions. First, we asked which distance between a baited red sphere trap and the nearest foliage and fruit gave rise to the greatest AMF captures. Second, we asked which part of the tree canopy (outer half or inner half) was the more favorable for positioning a baited red sphere trap to maximize captures. Finally, we asked whether the distance to which foliage and fruit were cleared away from a red sphere trap was of greater consequence to trap performance when traps were baited or when traps were not baited. For each question, we examined effects of season on the pattern of AMF response to traps.

Materials & Methods

All experiments were conducted in a city-owned apple orchard in Leominster, Massachusetts dedicated to honor Johnny Appleseed (a.k.a. John Chapman, who was born in Leominster). We used Jersey Mac trees on M.26 rootstock, which had a moderate amount of fruit each year. We also used Golden Delicious trees on M.7 rootstock, which also had a moderate amount of fruit each year. All trees involved in our trials were moderately well pruned and received periodic season-long treatments of fungicide to protect against apple diseases. They received insecticide treatments through May to protect fruit against early-season insect pests but none thereafter.

Each year, we conducted two experiments: one using Golden Delicious trees, the other using Jersey Mac trees. There were not enough trees of either cultivar to conduct both experiments each year using the same cultivar.

Spheres used as traps were wooden, 3.5 inches in diameter, and coated with Tangletrap to capture alighting AMF. When baited, a sphere received a single polyethylene vial containing a five-component blend of synthetic attractive apple volatiles positioned about 6 inches to the side of the sphere. Each year, spheres were deployed in mid-July and remained in place until mid-September. Each tree received a single sphere hung at head height.

Our first question was addressed in 2002 using Golden Delicious trees. Foliage and fruit were cleared to one of five distances (in a radius) around spheres: 0, 10, 20, 30, or 40 inches. For the 0-inch treatment, clearance was just enough to prevent foliage and fruit from touching the sphere. All spheres were odor-baited and hung in the outer half of the tree canopy. There were six replicates of each treatment.

Our second question was addressed in 2002 using Jersey Mac trees. Odor-baited spheres were deployed either in the outer or inner half of the tree canopy, with foliage and fruit cleared to a distance of either 10 or 20 inches. There were six replicates of each treatment.

Our third question was addressed in 2003 using both Jersey Mac and Golden Delicious trees. Spheres were either odor-baited or not baited. Spheres in Jersey Mac trees were deployed either in the outer half of the canopy with foliage and fruit cleared to a distance of 20 inches or in the inner half of the canopy with foliage and fruit cleared to a distance of 10 inches. Spheres in Golden Delicious trees were deployed in the outer half of the canopy with foliage and fruit cleared to a distance of either 20 or 40 inches.

Once per week, captured AMF, other insects of similar or larger size and debris were removed from spheres. If necessary, Tangletrap was renewed, new growth of foliage was pared back, and enlarging fruit that encroached upon prescribed clearance distances were removed. The sex of captured AMF was not recorded in 2002 but was recorded in 2003.

For each experiment, captured adults were separated into three groups according to season of capture. For captures in Jersey Mac trees, groups were mid-season (mid July to early August), late-season (early to late August), and post-harvest (late August to mid September). For captures in Golden Delicious trees, groups were early-season (mid July to early August), mid-season (early to late August) and late season (late August to mid-September).

Results

For our first question, data reveal that over the entire season in Golden Delicious trees, baited spheres with foliage and fruit cleared to 10 or 20 inches captured significantly more AMF than equivalent spheres having foliage and fruit cleared to 0 or 40 inches (Figure 1). Captures on spheres having foliage and fruit cleared to 30 inches were not significantly different from either group. This pattern characterized adult response to sphere treatments during early, mid and late season (Figure 1).

For our second question, results show that across the entire season in Jersey Mac trees, baited spheres

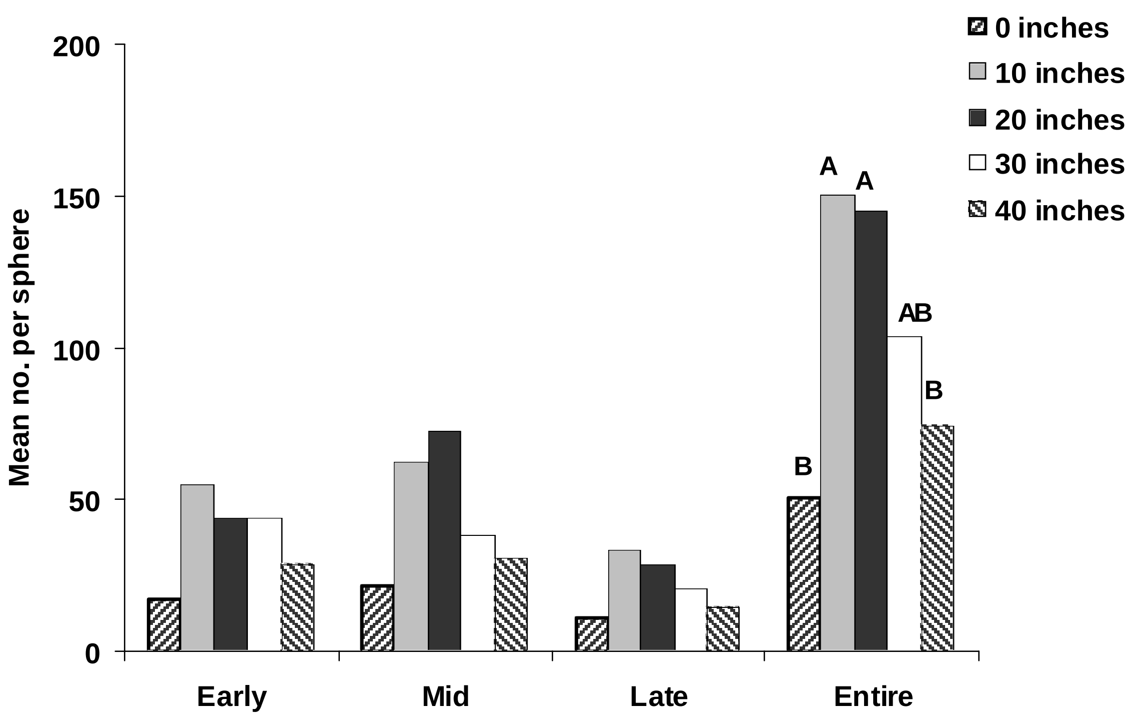

Figure 1. Mean number apple maggot flies captured per odor-baited sphere in Golden Delicious trees with foliage and fruit cleared to a radius of either, 0, 10, 20, 30, or 40 inches around a sphere. Captures were evaluated for early, mid, and late season and across the entire season. For the entire season, mean values superscribed by the same letter are not significantly different at odds of 19:1.

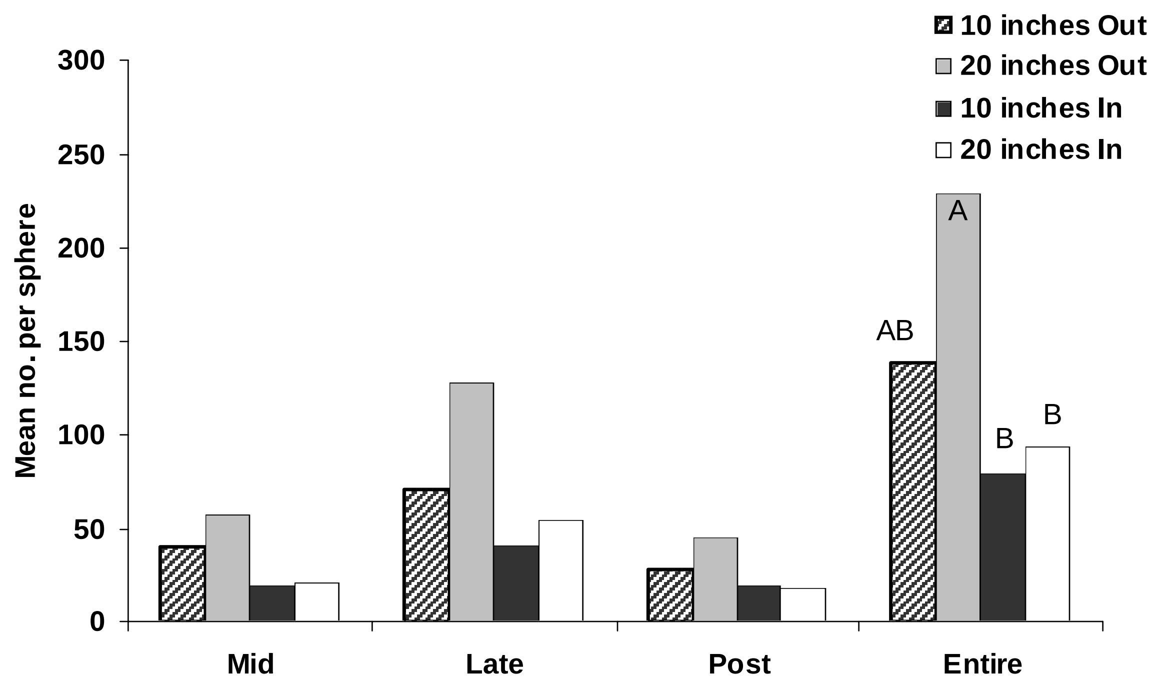

Figure 2. Mean number AMF captured per odor-baited sphere in Jersey Mac trees when spheres were either in the outer or inner half of the canopy and foliage and fruit were cleared to either 10 or 20 inches in a radius around the sphere. Captures were evaluated for mid, late, and post season and across the entire season. For the entire season, mean values superscribed by the same letter are not significantly different at odds of 19:1.

in the outer half of the canopy with foliage and fruit cleared to 20 inches captured significantly more AMF than equivalent spheres in the inner half of the canopy with foliage and fruit cleared to 10 or 20 inches (Figure 2). Captures on spheres placed in the outer half of the canopy with foliage and fruit cleared to 10 inches were not significantly different from the other treatments. This pattern characterized adult response to sphere treatments during mid, late and post season (Figure 2).

For our third question, data show that across the entire season in Jersey Mac trees, baited spheres placed in the outer half of the canopy with foliage and fruit cleared to 20 inches caught significantly more female AMF than baited spheres in the inner half of the canopy with foliage and fruit cleared to 10 inches (Figure 3). The same was true for males. On the other hand, there was no significant difference in response of either female or male adults to these two position treatments when spheres were unbaited. For each sex and each position, baited spheres captured significantly more adults than unbaited spheres. These patterns characterized the response of each sex to each position treatment during mid, late, and post season (Figure 3).

For our third question, data also reveal that across the entire season in Golden Delicious trees, baited spheres placed in the outer half of the canopy with foliage and fruit cleared to 20 inches caught significantly more female AMF than baited spheres in outer half of the canopy with foliage and fruit cleared to 40 inches (Figuire 4). Again, the same was true for males, again there was no significant difference in response of either sex to position treatments when spheres were unbaited, and again baited spheres in each position captured significantly more adults of each sex than unbaited spheres. These patterns held during early, mid and late season (Figure 4).

Conclusions

Combined findings show that AMF responded maximally to odor-baited red sphere traps when traps were hung in the outer half of the tree canopy and all

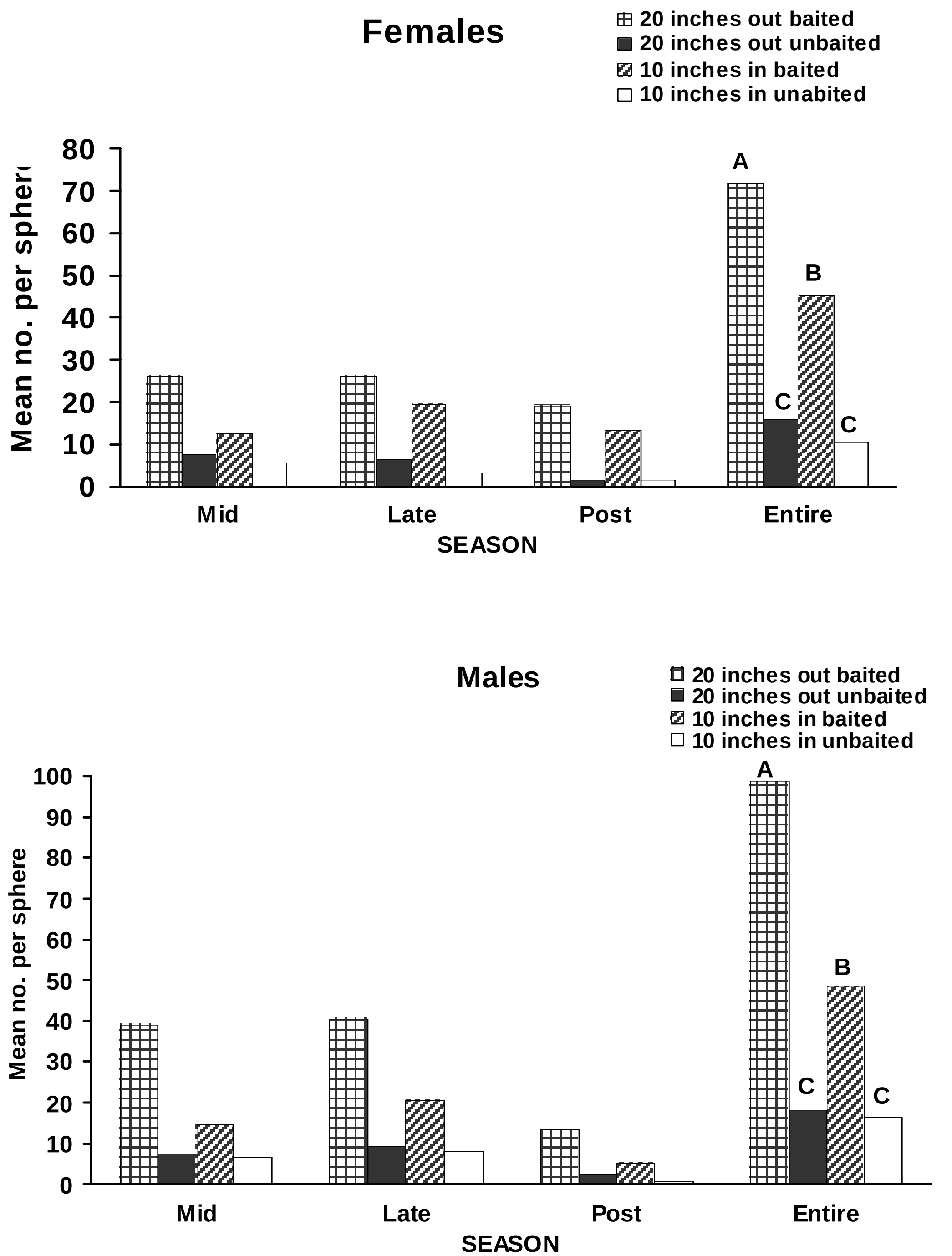

Figure 3. Mean number female and male AMF captured per odor-baited and unbaited sphere in Jersey Mac trees when spheres were either in the outer or inner half of the canopy and foliage and fruit were cleared to either 20 or 10 inches in a radius around the sphere. Captures were evaluated for mid, late, and post season and across the entire season. For the entire season, mean values superscribed by the same letter are not significantly different at odds of 19:1.

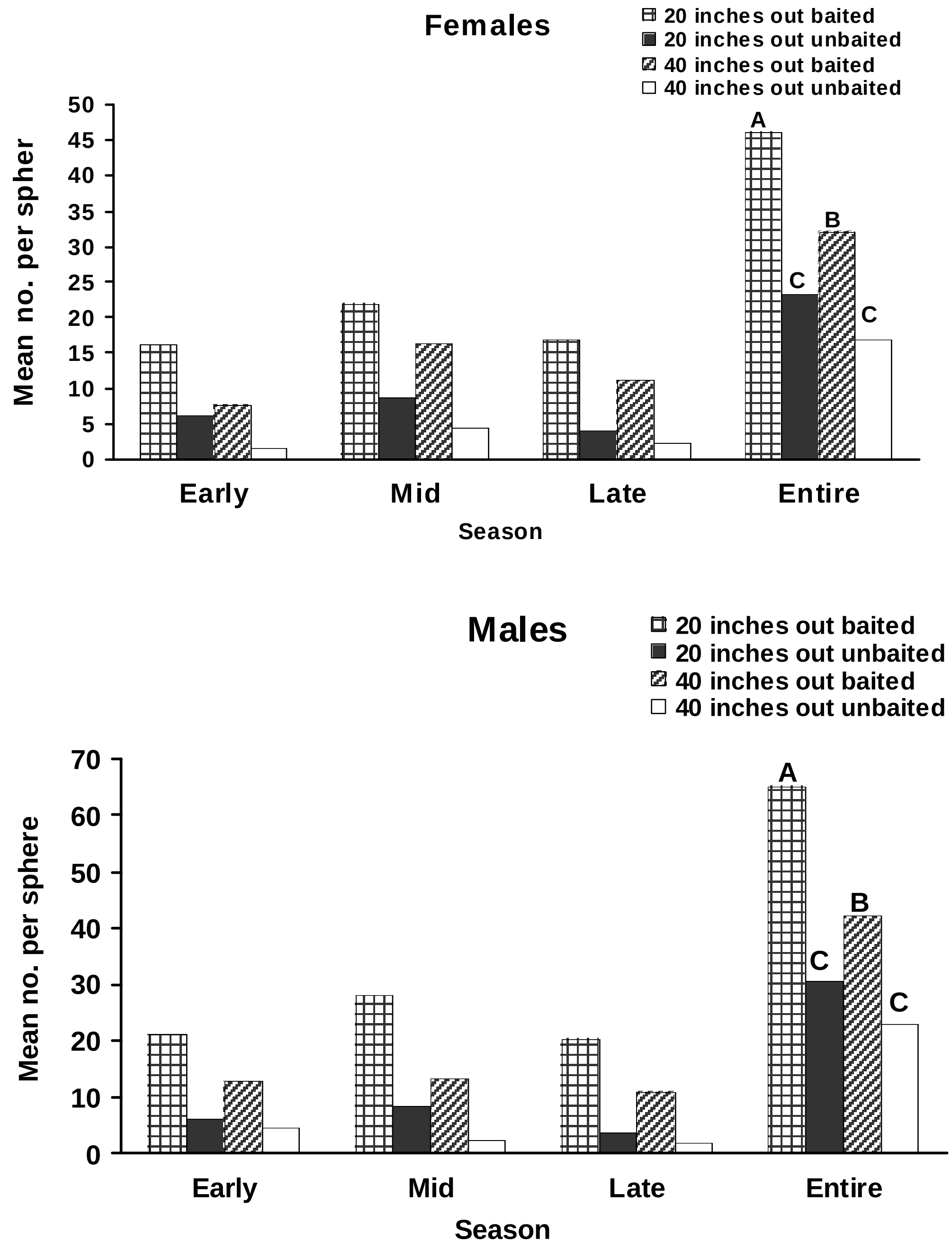

Figure 4. Mean number female and male AMF captured per odor-baited and unbaited sphere in Golden Delicious trees when spheres were in the outer half of the canopy and foliage and fruit were cleared to either 20 or 40 inches in a radius around the sphere. Captures were evaluated for early, mid, and late season and across the entire season. For the entire season, mean values superscribed by the same letter are not significantly different at odds of 19:1.

foliage and fruit within 10 to 20 inches of a trap was removed. Response was significantly or numerically less to baited spheres when spheres were hung in the inner half of the canopy (foliage and fruit cleared to 10 or 20 inches) or when spheres in the outer half of the canopy had foliage and fruit cleared to distances of 0, 30, or 40 inches. In contrast to baited spheres, unbaited spheres performed about as well when hung in sub-optimal position (either in the inner half of the canopy with foliage and fruit cleared to 10 inches or in the outer half of the canopy with foliage and fruit cleared to 40 inches) as when in optimal position (in outer half of the canopy with foliage and fruit cleared to 20 inches). Patterns of adult response to sphere treatments were essentially the same during each phase of the fruit development season.

In our experiments, use of a five-component blend of synthetic apple volatiles in association with red spheres not only significantly enhanced attractiveness of spheres but also significantly accentuated degree of differential response to varying within-tree sphere positions compared with response to unbaited spheres. For example, adults responded equally to outer-canopy spheres with foliage and fruit cleared to 20 inches and inner-canopy spheres with foliage and fruit cleared to 10 inches when spheres were unbaited but significantly favored the former over the latter when spheres were baited. Causes underlying this and similar differential response patterns found here are unknown but could involve an interaction between presence of synthetic fruit odor and visual apparency of spheres that favors discovery of baited spheres in positions where the integrity of a synthetic odor plume and the conspicuousness of a sphere are not compromised by an overabundance of nearby foliage and fruit (e.g., as at a distance of 0 or even 10 inches) or an insufficient amount of light (e.g., as at interior of canopy). Too little nearby foliage and fruit, however, as for odor-baited spheres having foliage and fruit cleared to 40 inches, is just as unfavorable as too much nearby foliage and fruit, possibly in part because AMF are less able to visually detect 3.5-inch red spheres at a distance of 40 inches compared with closer distances.

In summary, our results suggest that maximal success in using a red sphere for monitoring or controlling AMF can be achieved by baiting a sphere with a five component blend of attractive odor, positioning the sphere in the outer half of an apple tree canopy, clearing away all foliage and fruit within 20 inches of the sphere, and allowing foliage and fruit beyond that distance to remain.

Acknowledgments

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